A-677719
-9914

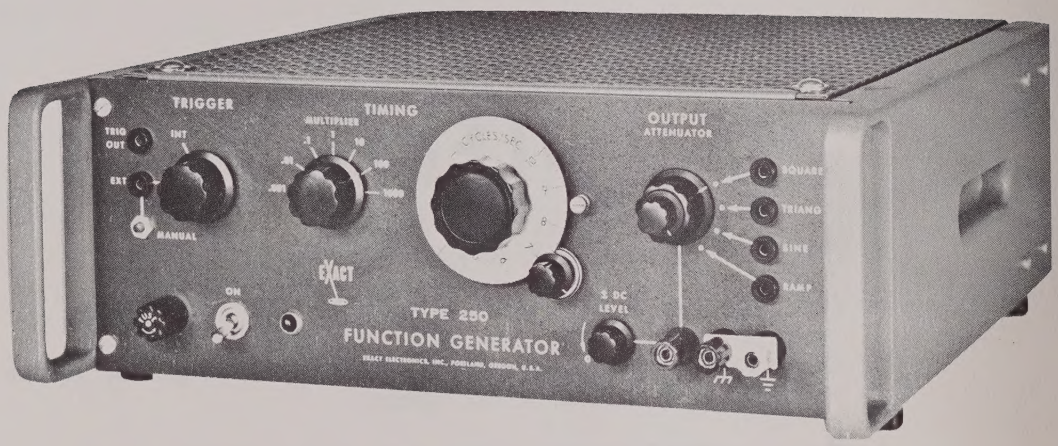
P/O A-677719-9914 P.C.
Jd # 650279-00 Cal dw
BO # 534795
534796
SEP 9 - 1965

EXACT

ELECTRONICS, INC.

INSTRUCTION MANUAL

Type 250 s/n 2066



INSTRUCTION MANUAL

Type 250 **s/n** 2066

EXACT Electronics, Inc

455 S. 2ND AVE.
HILLSBORO, OREGON
PHONE (503) 648-6661
TWX (503) 821-6927

Copyright © 1962 by Exact Electronics, Inc., Hillsboro, Oregon. Printed in the U.S.A. All rights reserved. Contents of this publication may not be reproduced in any form without permission of the copyright owner.

IF YOUR INSTRUMENT DOES NOT OPERATE

PLEASE

1. Check operating procedure in manual for proper set-up.
2. Check fuse and power supply voltages.
3. Consult the brief trouble shooting guide at the beginning of the MAINTENANCE section of this manual.
4. Call your EXACT representative or the factory collect.

A new instrument should operate properly on arrival and no-one wishes this more than Exact. Many things keep this from happening in every case and if yours is the exception, you should be inconvenienced as little as possible. Some people like to find a trouble themselves, others prefer not to touch an instrument without representation from the manufacturer. **YOUR WARRANTY WILL IN NO WAY BE AFFECTED BY YOUR EFFORT TO FIND THE TROUBLE AND PUT YOUR INSTRUMENT IN EARLY OPERATION.** We leave it to your judgment and offer the services of our representatives and our factory to give you the assistance you need.

WARRANTY

All Exact instruments are fully guaranteed against defective materials and workmanship for one year. Replacement parts requests should be clearly identified and the instrument serial number given. The needed parts will be air shipped to you within 24 hours.

INDEX

SECTION I - OPERATION

1.1 SPECIFICATIONS
1.2 FRONT PANEL FAMILIARITY
1.3 PURPOSE
1.4 OPERATION
1.5 APPLICATIONS

SECTION II - MAINTENANCE

2.1 BLOCK DIAGRAM
2.2 CHASSIS LAYOUT
2.3 CIRCUIT DESCRIPTION
2.4 TROUBLESHOOTING PROCEDURE
2.5 RESISTANCE/DC VOLTAGE CHARTS
2.6 WAVEFORM CHART

SECTION III - CALIBRATION

3.1 POWER SUPPLY
3.2 TIMING
3.3 TRIANGLE LINEARITY
3.4 SINE WAVE CALIBRATION
3.5 RAMP WAVE CALIBRATION
3.6 DC LEVELS AND OUTPUT AMPLITUDES
3.7 INPUT TRIGGER CHECKS

SECTION IV - PARTS LIST

SECTION V - CIRCUIT DIAGRAM

SECTION 1 OPERATION

1.1 - SPECIFICATIONS

1.2 - FRONT PANEL FAMILIARITY

1.3 - PURPOSE

1.4 - OPERATION

1.5 - APPLICATIONS

PLEASE NOTE THE FOLLOWING CORRECTIONS TO THE SPECIFICATIONS

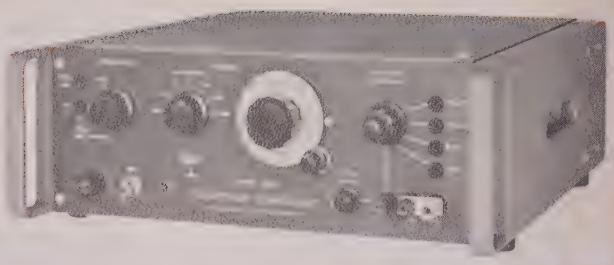
EXTERNAL TRIGGERING

TRIGGER INPUT PULSE SHOULD READ -15 VOLTS AMPLITUDE.

MAIN OUTPUT

FREQUENCY DEVIATION FROM ABSOLUTE SHOULD READ
DIAL ACCURACY .... 2% MAXIMUM DIAL READING.

TYPE 250 FUNCTION GENERATOR



TYPE 250 FUNCTION GENERATOR

TYPE 250 FUNCTION GENERATOR

Here's a Function Generator that can be externally triggered, and produces six separate outputs simultaneously. Four of the output waveforms - square, triangle, sine and ramp - are fixed amplitude auxiliary outputs. The fifth output (Main) is switched to provide any one of the four function-waveforms with adjustable amplitude and dc reference level. The sixth output is a trigger-output signal for use by associated equipment. In externally triggered mode, one input trigger pulse produces one complete cycle at all six outputs, simultaneously. The Exact Type 250 is a dependable, general purpose instrument, ideal for use in circuit design, equipment checkout and calibration, quality control, and other production and systems applications.

SIMULTANEOUS OUTPUTS

All outputs of the 250 are simultaneous and synchronized throughout the entire frequency range of the generator. Phase relationship is unique in that the triangle and sine waveform peaks occur at the rise and fall points of the square waveform.

MAIN OUTPUT

The main output is switched to any one of the four function waveforms and provides amplitude adjustment from 300mv to over 25 volts p-p. Dc reference level is adjustable from -15 to +15 volts, and is referenced to chassis ground or, by removing a strap, can be referenced to circuit ground which is then isolated from the chassis.

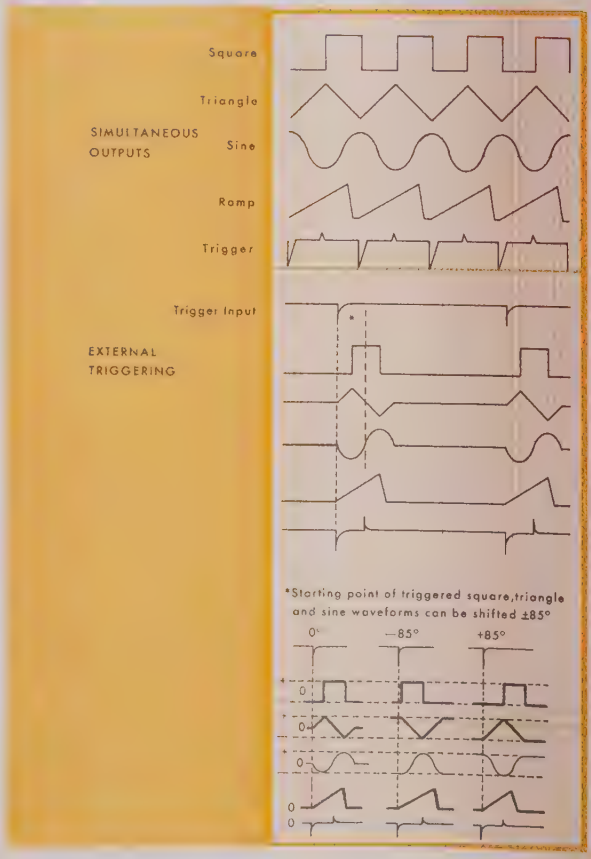
EXTERNAL TRIGGERING

The 250's flexibility is best demonstrated when operated in the externally-triggered mode. In this mode, one trigger pulse produces one complete cycle at all outputs, simultaneously. A pushbutton permits manual triggering of the outputs for oneshot applications. Triggered waveforms are adjustable (timing controls) from 100 usecs to over 16 minutes duration. Also, the starting point of triggered waveforms (all except ramp) can be shifted ±85° (internal adjustment) as shown in the illustration at right.

PHYSICAL CHARACTERISTICS

The 250 is 5-1/4" high by 15-1/2" wide, and has a net weight of only 19 pounds. The generator can be supplied in rackmount version (250RM) at no additional cost. Front panel is of dark grey color, with silkscreened white panel designations. End bells and cabinet are medium grey. All exterior finishes are oven baked for durability.

- SIMULTANEOUS OUTPUTS
- SQUARE-TRIANGLE-SINE-RAMP
- 300mv to 25 volts P-P
- 0.001cps to 10kc
- TRIGGERED or FREE-RUNNING



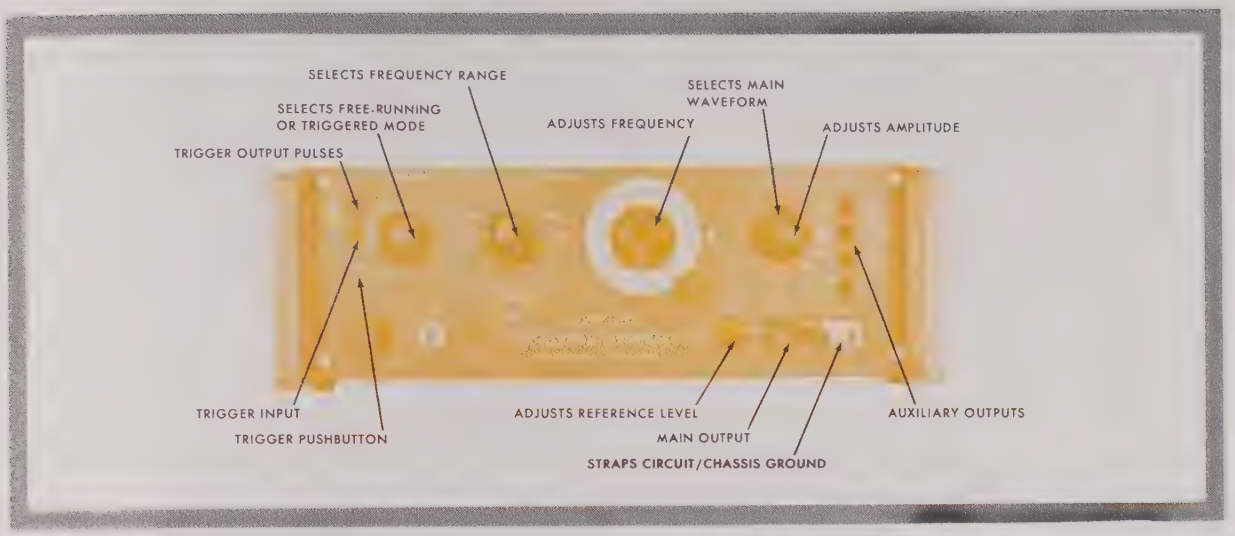
EXACT Electronics, Inc

EXACT ELECTRONICS INC.

455 S.E. 2nd Avenue, Hillsboro, Oregon 97123

printed in U.S.A.

S-250.2 9-64



SPECIFICATIONS

MAIN OUTPUT

Amplitude* . . . . . 300 mv to 25 volts p-p (min)
. . . . . 25 volts into 5K load
Stability/Repeatability . . . [illegible]
Amplitude Change with Frequency . . 1% to 10 kc

Amplitude Change with Function . . . . . 2% max
DC Reference Level Range* . . . . . .
. . . . . -15 volts or ±15 volts or switched to 0v
Frequency Range . . . . . 0.001 cps to 10 kc
Frequency Deviation from Absolute . . . . . 3% max
Long Term Frequency Stability . . . . . ±1%

EXTERNAL TRIGGERING

Trigger Input Pulse . . . . . 1 usec risetime (min)
. . . . . -10v min amplitude
less than 1 usec delay from -10v point
. . . . . and start of waveform

POWER REQUIREMENTS

Line Voltage . . . . . 105 to 125 or 200 to 250 vac
Line Frequency . . . . . 50 to 400 cps
Power . . . . . 150 watts

TRIGGER OUTPUT

Waveform . . . . . differentiated squarewave
Amplitude . . . . . -25v (min)

PHYSICAL CHARACTERISTICS

Weight . . . . . 19 lbs net, 26 lbs gross
Volume . . . . . 2 cu ft gross
Dimensions . . . . . 15-1/2w X 5-1/4h X 13d

SQUARE WAVEFORM

Risetime . . . . . 5 usecs or faster
Symmetry 99.5%
Overshoot . . . . . 1% max
Droop . . . . . 1% max

TRIANGLE WAVEFORM

Linearity 99.5%
Symmetry 99.5%

SINE WAVEFORM

Total Distortion . Less than 2% over entire freq. range

RAMP WAVEFORM

Linearity 99.5%
Fall Time . . . . . Less than 6% to 1 kc
Less than 10% to 10 kc
Dead Time† . . . . . Less than 6% to 1 kc
Less than 10% to 10 kc

AUXILIARY OUTPUTS

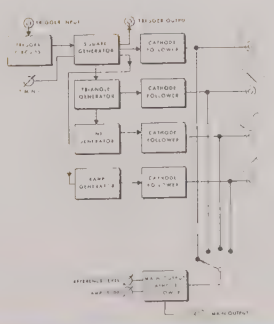
Amplitude* . . . . . 30 volts p-p (min)
30 volts into 7K load
Stability/Repeatability . . . . . (same as main)
Amplitude Change with Frequency . . . . . (same as main)
DC Reference Level . . . . . 0 volts (fixed)
Frequency Range . . . . . Synchronized with main

* Max Current: 15 ma @ +15 vdc reference level
3 ma @ -15 vdc reference level

† Ramp dead time can be reduced to less than 1% at any one frequency (internal adjustment)

PRICE

F.O.B. Factory . . . . . $ 595.00



For the location of your nearest representative, consult Electronic Engineers Master.

eem File 2900

EXACT Electronics, Inc

EXACT ELECTRONICS INC.

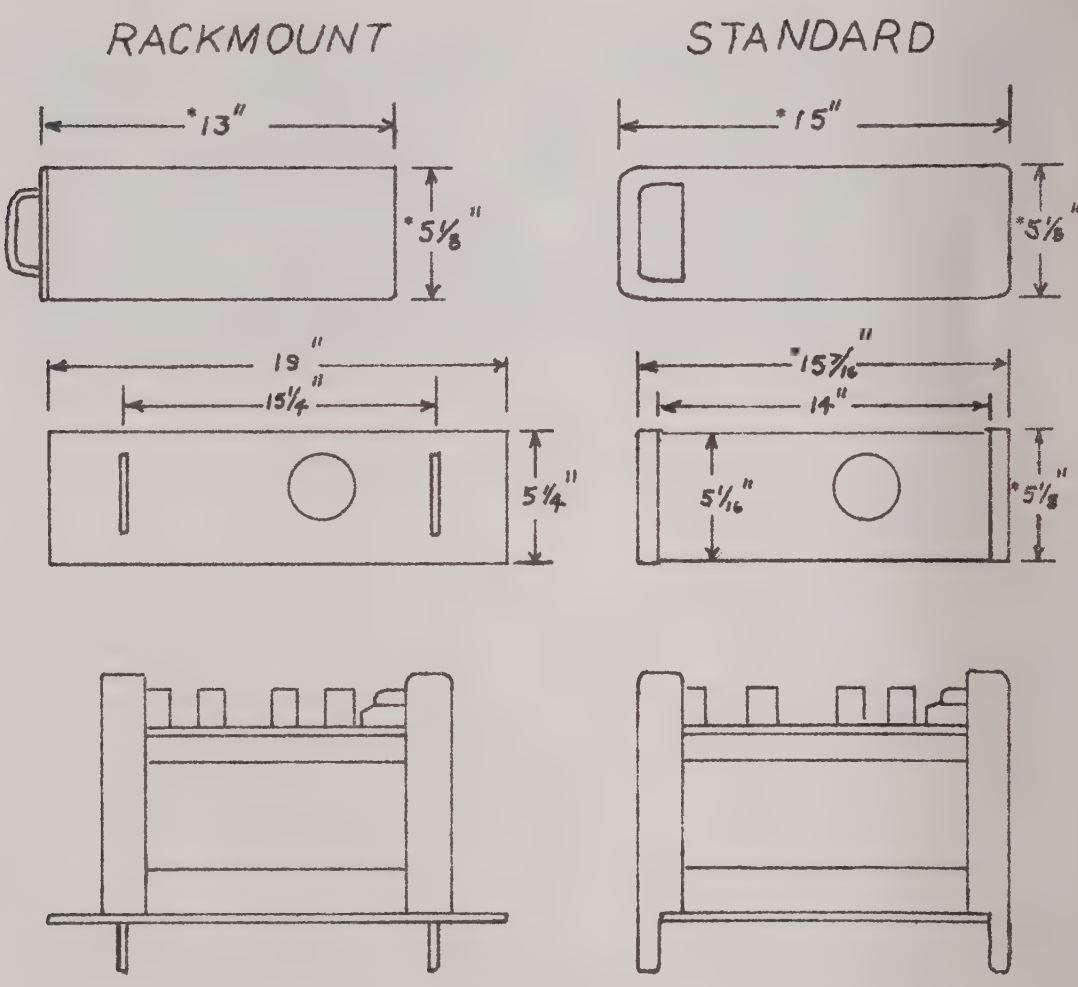
[illegible] Oregon [illegible]

Telephone (503) 648-6661

TWX: 503-821-6927

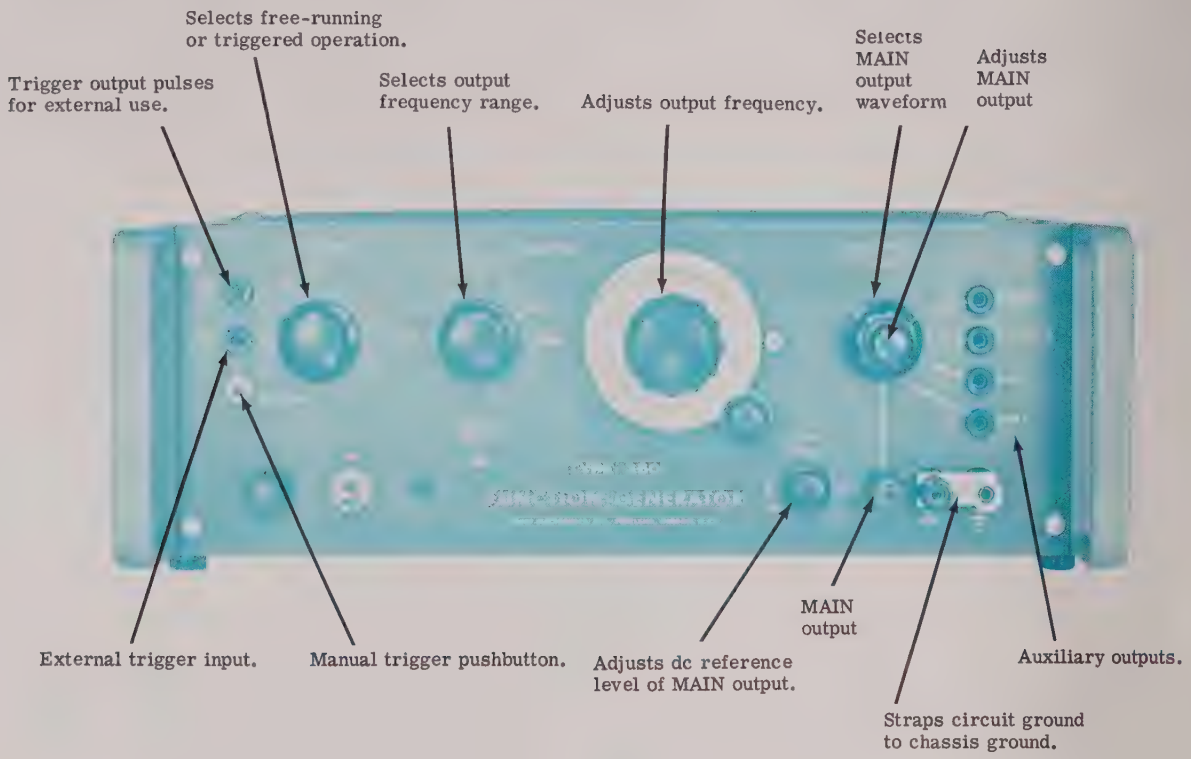
1.1 SPECIFICATIONS (CONTINUED)

DIMENSIONS:



* THESE MEASUREMENTS ARE CORRECT WITHIN ±1/16" DUE TO THE CASTING OF THE ALUMINUM ENDBELLS.

1.2 FRONT PANEL FAMILIARITY


Selects free-running or triggered operation.
Trigger output pulses for external use.
Selects output frequency range.
Adjusts output frequency.
Selects MAIN output waveform
Adjusts MAIN output
MAIN output
External trigger input.
Manual trigger pushbutton.
Adjusts dc reference level of MAIN output.
Auxiliary outputs.
Straps circuit ground to chassis ground.

1.2.1. TIMING

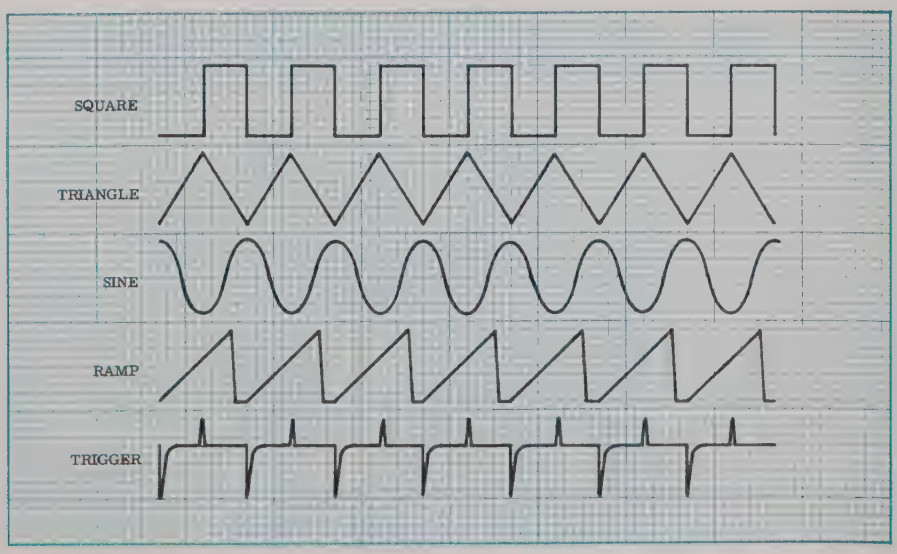
(a) TIMING RANGE:
0.001 CPS to 10,000 CPS

(b) TIMING ACCURACY:
Maximum 2% deviation between any combination of multiplier and dial setting and absolute time.

(c) TIMING STABILITY:
Maximum 1% deviation from original set frequency over a 24 hour period. Timing is more critical at X1 end of the CYCLES/SEC dial.

1.2.2. OUTPUT

(a) TIME-PHASE RELATIONSHIP OF OUTPUT:



1.2.2. OUTPUT (CONTINUED)

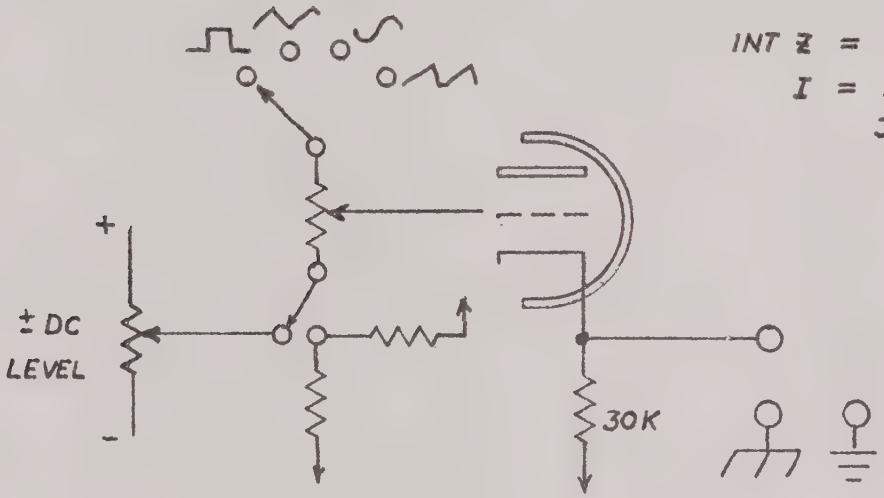
(B) MAIN OUTPUT

(1) AMPLITUDE ..... 300MV TO AT LEAST 25V PP

(2) DC COMPONENT ... FIXED AT ZERO VOLTS OR VARIABLE FROM -13V TO +13V (MINIMUM RANGE)

(3) STABILITY ..... 50MV SHORT TERM
150MV LONG TERM

(4) IMPEDANCE .....



(C) POLARITY

CIRCUIT GROUND CAN BE ISOLATED FROM CABINET GROUND BY REMOVING THE INTERCONNECTING STRAP. THE OUTPUT WILL NOW BE FLOATING. IF YOU DO NOT LOAD THE OUTPUT, THERE WILL BE SOME HUM PICKUP AND A 1 µFD CAPACITOR SHOULD BE PLACED BETWEEN THE TWO GROUND POSTS.

MAXIMUM ELEVATION POTENTIAL -- 500V

(D) DC LEVEL

THE ABOVE SKETCH ILLUSTRATES THE OPERATION AND RANGE OF THE ± DC LEVEL POTENTIOMETER. WHEN THIS POTENTIOMETER IS IN THE "SWITCHED" OR "C" POSITION, THE WAVEFORMS SHOULD HAVE A CENTER 0 DC LEVEL. INTERNAL ADJUSTMENTS ON ALL WAVEFORMS ASSURE THAT THIS CAN ALWAYS BE TRUE. THE SINE, SQUARE AND RAMP OFFSETS ARE SIMILAR TO THE ABOVE TRIANGLE OFFSETS.

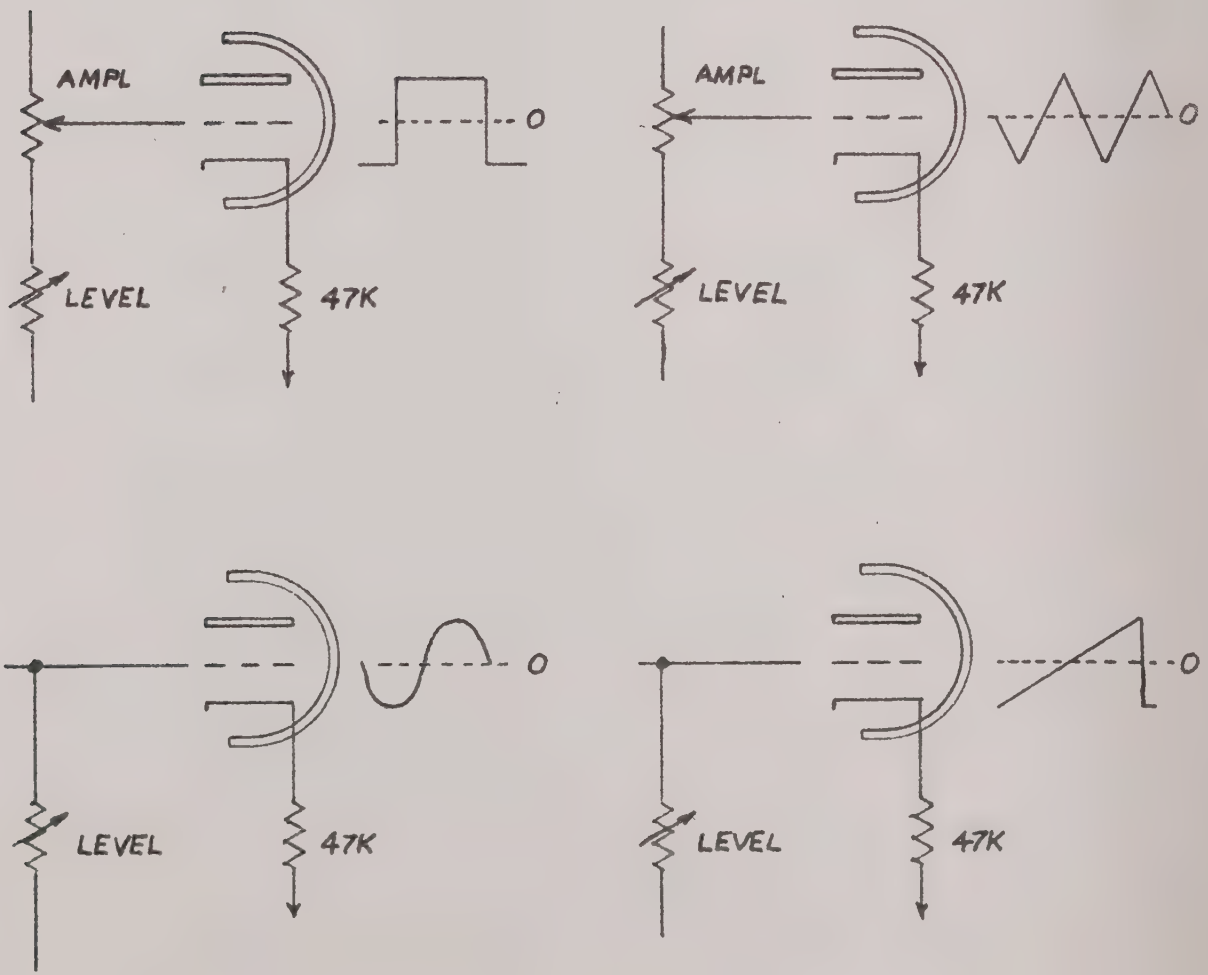
1.2.2 OUTPUT (CONTINUED)

(E) AMPLITUDES

THE AMPLITUDES OF ALL WAVEFORMS ARE THE SAME WITHIN 2%. INTERNAL ADJUSTMENTS ON THE SQUARE AND TRIANGLE WAVEFORMS ASSURE THAT THEIR AMPLITUDES CAN BE ADJUSTED TO WITHIN 2% OF THE SINE WAVE AMPLITUDE.

(F) SIMULTANEOUS OUTPUTS

THE SIMULTANEOUS OUTPUT WAVEFORMS ARE AT A FIXED DC LEVEL (INTERNAL ADJUSTMENT). THE AMPLITUDES OF THE SQUARE AND TRIANGLE WAVEFORMS ARE INTERNALLY ADJUSTABLE.



1.3 PURPOSE

THE GENERAL PURPOSE OF THE 250 IS TO GENERATE SQUARE, SINE, TRIANGLE AND RAMP WAVEFORMS OVER A CONTINUOUSLY VARIABLE FREQUENCY RANGE OF 0.001 CYCLES/SEC TO 10,000 CYCLES/SEC. THESE WAVEFORMS ARE AVAILABLE SIMULTANEOUSLY FROM THE DESIGNATED JACKS ON THE RIGHT HAND SIDE OF THE FRONT PANEL OR SINGLY AS SELECTED FROM THE MAIN OUTPUT JACK. THESE WAVEFORMS MAY BE CONTINUOUS, EXTERNALLY TRIGGERED, OR TRIGGERED BY THE MANUAL PUSH BUTTON.

1.4 OPERATION

FOR THE FIRST TIME OPERATION, THE FOLLOWING PROCEDURE SHOULD BE USED:

(A) CHECK THE STRAP BETWEEN THE GROUND POSTS.

(B) SET THE POWER SWITCH TO ON.

(C) ALLOW A TEN-MINUTE WARM-UP PERIOD.

(D) SET THE OUTPUT SWITCH TO TRIANGLE.

(E) TURN OUTPUT ATTENUATOR (RED CONCENTRIC KNOB) FULLY CLOCKWISE.

(F) SET THE FREQUENCY MULTIPLIER AND CYCLES/SEC DIAL TO THE DESIRED FREQUENCY.

(G) SET THE ±DC LEVEL TO 0 (SWITCH CLOSED) POSITION OR TO THE OUTPUT LEVEL DESIRED.

(H) CONNECT THE MAIN OUTPUT AND/OR SIMULTANEOUS OUTPUT TO THE SYSTEM, CIRCUITS, AND THE OSCILLOSCOPE, ETC.

(J) SET THE TRIGGER SWITCH TO INTERNAL.

(K) CONNECT THE TRIGGER OUT JACK TO THE EXTERNAL TRIGGER INPUT OF THE MONITOR OSCILLOSCOPE.

1.5 APPLICATIONS

(A) GENERAL WAVEFORM SOURCE FOR RESEARCH, ANALOG COMPUTERS, AND SYSTEMS CHECKING

(B) THE LOW FREQUENCY SQUARE WAVE FOR RESPONSE CHECKS

(C) THE TRIANGLE AS A RASTER GENERATOR

(D) THE RAMP AS A SWEEP VOLTAGE FOR MONITOR SCOPES, RECORDERS, ETC

(D) LINEARITY CHECKING OF INSTRUMENTS OR SYSTEMS BY VARYING THE DC LEVEL, AMPLITUDE, OR FREQUENCY WHILE HOLDING ONE OR BOTH OF THE OTHER PARAMETERS CONSTANT

1.5 APPLICATIONS (CONTINUED)

(F) AS A DELAY TRIGGER GENERATOR (TRIGGER THE TYPE 250 EXTERNALLY AND USE THE SQUARE OR RAMP FALL, WHICH IS VARIABLE OVER THE ENTIRE TIMING RANGE) TO TRIGGER THE OSCILLOSCOPE OR OTHER EQUIPMENT.

(G) SERVO SYSTEMS CHECKING.

(H) WAVEFORMS CAN BE DIRECTLY MIXED BY PATCHING TOGETHER THE SIMULTANEOUS AND MAIN OUTPUTS AT THE FRONT PANEL TO PRODUCE COMPLEX WAVEFORMS. IF YOU WISH TO OFFSET SOME OF THE SIMULTANEOUS OUTPUTS, INTERNAL ADJUSTMENTS CAN BE MADE.

SECTION II MAINTENANCE

2.1 - BLOCK DIAGRAM

2.2 - CHASSIS LAYOUT

2.3 - CIRCUIT DESCRIPTION

2.3.1 Power Supply
2.3.2 Square Wave Generator
2.3.3 Triangle Generator
2.3.4 Sine Wave Generator
2.3.5 Ramp Generator
2.3.6 Main Output
2.3.7 Simultaneous Outputs
2.3.8 External Trigger

2.4 - - - - - - - - - - - - - - - - - - - TROUBLESHOOTING PROCEDURE

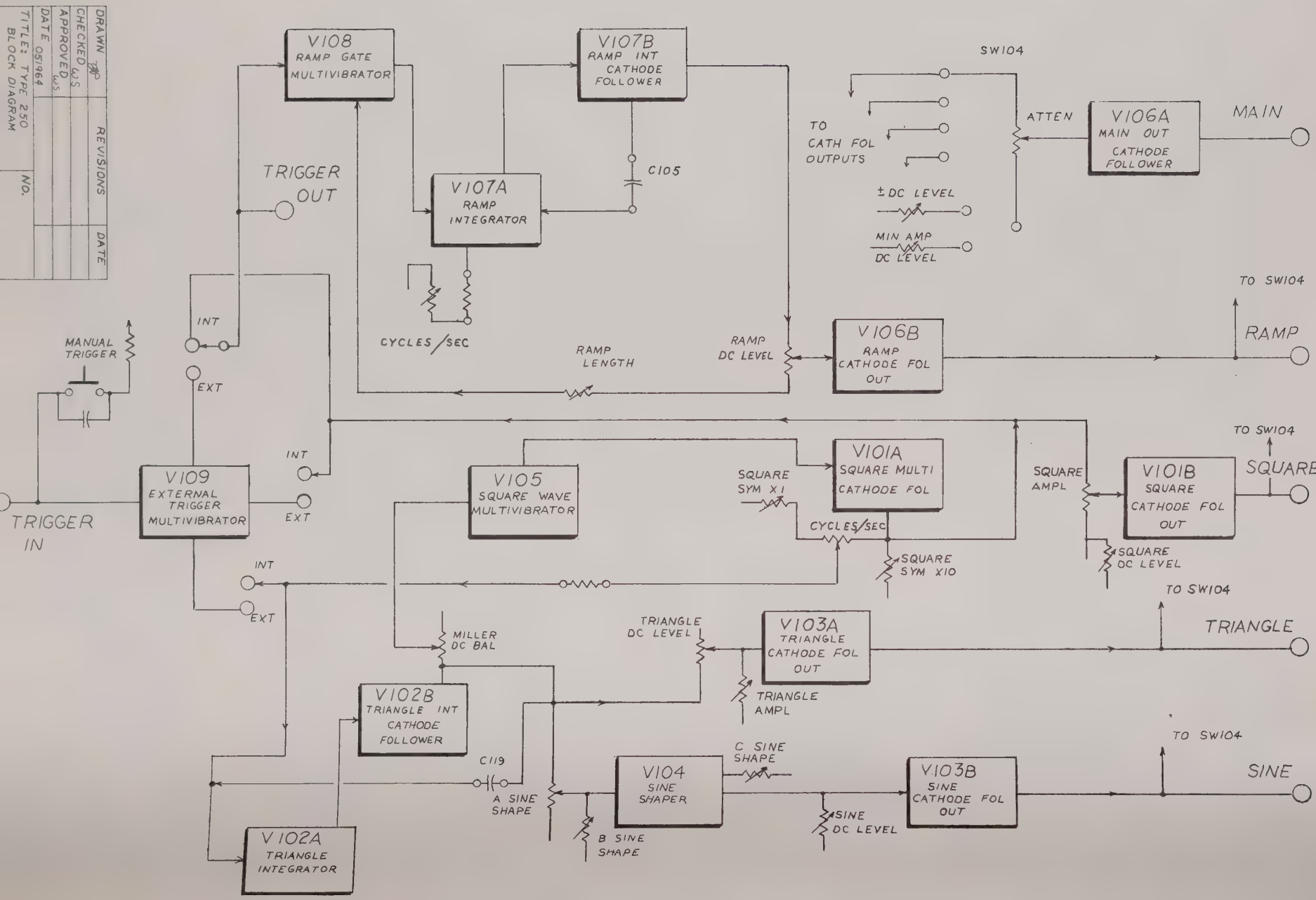
2.4.1 Power Supply
2.4.2 Square Wave
2.4.3 Triangle
2.4.4 Sine
2.4.5 Ramp
2.4.6 Multiple Problems

2.5 - - - - - - - - - - - - - - - - RESISTANCE AND DC VOLTAGE CHARTS

2.5.1 Power Supply Resistance and DC Voltage Chart
2.5.2 Main Chassis Resistance and DC Voltage Chart

2.6 - - - - - - - - - - - - - - WAVEFORM AMPLITUDE AND DC LEVEL CHART

CAUTION To assure drift-free operation within the instrument capabilities, aged tubes should be used for replacement.


TITLE: TYPE 250 BLOCK DIAGRAM
NO.
DATE 05/1964
APPROVED WS
CHECKED WS
DRAWN
REVISIONS
DATE
V108 RAMP GATE MULTIVIBRATOR
V107B RAMP INT CATHODE FOLLOWER
V107A RAMP INTEGRATOR
C105
TRIGGER OUT
CYCLES/SEC
RAMP LENGTH
SW104
TO CATH FOL OUTPUTS
ATTEN
V106A MAIN OUT CATHODE FOLLOWER
MAIN
± DC LEVEL
MIN AMP DC LEVEL
TO SW104
RAMP
V106B RAMP CATHODE FOL OUT
RAMP DC LEVEL
INT
EXT
MANUAL TRIGGER
V109 EXTERNAL TRIGGER MULTIVIBRATOR
TRIGGER IN
V105 SQUARE WAVE MULTIVIBRATOR
V101A SQUARE MULTI CATHODE FOL
SQUARE SYM X1
CYCLES/SEC
SQUARE SYM X10
SQUARE AMPL
V101B SQUARE CATHODE FOL OUT
SQUARE
SQUARE DC LEVEL
TO SW104
MILLER DC BAL
TRIANGLE DC LEVEL
V103A TRIANGLE CATHODE FOL OUT
TRIANGLE
TRIANGLE AMPL
V102B TRIANGLE INT CATHODE FOLLOWER
C119
A SINE SHAPE
B SINE SHAPE
V104 SINE SHAPER
C SINE SHAPE
V103B SINE CATHODE FOL OUT
SINE
SINE DC LEVEL
V102A TRIANGLE INTEGRATOR

2.3 CIRCUIT DESCRIPTION

2.3.1 POWER SUPPLY

THE THREE POWER SUPPLIES ARE ALL BASED ON THE SAME PRINCIPLE: A DC AMPLIFIER IS REFERENCED TO A STANDARD VOLTAGE (A 5651 GAS TUBE OR PRECISION DIVIDERS FROM -210V). ANY VARIATION FROM LINE OR LOAD IS AMPLIFIED BY THE DC AMPLIFIER AND PASSED ALONG AS A CONTROL VOLTAGE TO THE SERIES REGULATOR TUBE. THE FILAMENT SUPPLY IS REGULATED BY A TRANSISTOR REFERENCED TO A ZENER DIODE.

2.3.2 SQUARE WAVE GENERATOR

(A) V105 IS A CATHODE COUPLED MULTIVIBRATOR. ITS OUTPUT (PIN #6) SWINGS FROM BELOW -100V, WHEN V105B IS CONDUCTING, TO +100V WHEN IT IS CUT OFF. THE TIME DURATION OF EACH HALF-CYCLE IS DETERMINED BY THE TRIANGLE WAVEFORM AT GRID PIN #9 OF V105A. THE TRIANGLE WAVEFORM DETERMINES THE SWITCHING OF THE MULTIVIBRATOR. THE TRIANGLE MUST ALWAYS PASS THROUGH THE SAME DC LEVELS TO SWITCH V105 AND THEREFORE THIS PARTLY DETERMINES THE TIMING OF THE INSTRUMENT.

(B) THE LOOP GAIN OF THE CATHODE COUPLED MULTIVIBRATOR IS DETERMINED BY ITS CATHODE CURRENT. THIS DETERMINES THE FINAL TIMING AND IS CONTROLLED BY R161.

(C) V101A IS A CATHODE FOLLOWER WHOSE OUTPUT PROVIDES FOUR FUNCTIONS:

(1) SQUARE WAVE SYMMETRY (X10), R173 PROVIDES FOR EQUAL VOLTAGE BUT OPPOSITE POLARITY AT X10 END OF CYCLES/SEC DIAL FOR EACH HALF-CYCLE OF V105.

(2) PROVIDES STANDARD SQUARE WAVE TO OUTPUT CATHODE FOLLOWER V101B.

(3) PROVIDES SQUARE WAVE TO MILLER INTEGRATOR TIMING RESISTORS AND CAPACITORS (R134-R136 AND C119(A-F).

(4) PROVIDES SQUARE WAVE TO RAMP GATE V108 AND "TURN-OFF" VOLTAGE TO EXTERNAL TRIGGER MULTIVIBRATOR, V109.

2.3.3 TRIANGLE GENERATOR

V102 IS A MILLER INTEGRATOR AMPLIFIER WITH AN ASSOCIATED CATHODE FOLLOWER. THE SYMMETRICAL SQUARE WAVE FROM V101A IS FED TO GRID PIN #2 OF V102A AND THE INTEGRATOR ACTION PRODUCES A TRIANGLE WAVEFORM AT THE CATHODE (PIN #8 OF V102B) TIME CONSTANTS FOR THE INTEGRATOR ARE C119 (A-F), AND R169, R170 AND R171. MILLER DC BAL R188 DETERMINES THE LEVEL AND AMPLITUDE OF THE SIGNAL BEING FED BACK TO THE GRID PIN #9 OF V105.

2.3.4 SINE WAVE GENERATOR

V104 IS A PENTODE WHOSE BIAS CHARACTERISTICS ARE ADJUSTED BY THREE SINE SHAPING ADJUSTMENTS, R185, R193 AND R202. THE LINEAR TRIANGLE FROM V102B IS SHAPED BY THESE ADJUSTMENTS TO PRODUCE A VERY LOW DISTORTION SINE WAVE AT THE PLATE PIN #5.

SINE ADJ A (R185) CONTROLS THE DC LEVEL OF THE GRID.

SINE ADJ B (R193) CONTROLS THE AMPLITUDE OF THE TRIANGLE INTO GRID PIN #1 OF V104.

SINE ADJ C (R202) CONTROLS THE SUPPRESSOR BIAS OF V104.

2.3.5 RAMP GENERATOR

V108 IS A CATHODE COUPLED MULTIVIBRATOR WHICH SHAPES THE RELATIVELY SLOW RISE SQUARE WAVE INPUT TO A FAST RISE GATE TO START THE MILLER INTEGRATOR V107A. RUNUP ACTION IS STARTED BY THE GATING PULSE FROM V108. TIMING CONSTANTS ARE R112, R113, R114, R115 AND C105 (A-F). D102 AND D103 RETURN THE TIMING CAPACITOR TO THE PROPER QUIESCENT OPERATING LEVEL AFTER RUNUP.

V107B FURNISHES THE NECESSARY PLATE TO GRID FEEDBACK FOR THE INTEGRATOR AND IS ALSO THE CATHODE FOLLOWER TAKE-OFF TO THE OUTPUT AMPLIFIER.

RAMP LENGTH (R123) DETERMINES THE NECESSARY VOLTAGE LEVEL TO RESET THE GATING MULTI V108 WHICH IN TURN STOPS THE RUNUP AND TERMINATES THE RAMP.

2.3.6 MAIN OUTPUT

V106A IS A CONVENTIONAL CATHODE FOLLOWER. THE PROPER WAVEFORM BEING FED TO THE GRID IS SELECTED BY THE OUTPUT SWITCH, SW104. THE DC LEVEL OF THE CONTROL GRID IS DETERMINED BY:

(A) R130, R134 AND R135 IF ±DC OUTPUT LEVEL SWITCH IS CCW IN SWITCHED POSITION.

(B) R162 IF ±DC OUTPUT LEVEL SWITCH IS CW FROM SWITCHED POSITION.

2.3.7 SIMULTANEOUS OUTPUTS

V101B, V103A, V103B AND V106B ARE THE STANDARD CATHODE FOLLOWERS PROVIDING LOW IMPEDANCE OUTPUTS FOR THE INDIVIDUAL SQUARE, TRIANGLE, SINE AND RAMP WAVEFORMS. THE SINE WAVE CATHODE FOLLOWER V103B AND THE RAMP WAVE CATHODE FOLLOWER V106B HAVE DC LEVEL CONTROLS ONLY WHILE THE SQUARE WAVE CATHODE FOLLOWER V101B AND THE TRIANGLE CATHODE FOLLOWER V103A HAVE BOTH DC LEVEL AND AMPLITUDE CONTROLS.

2.3.8 EXTERNAL TRIGGER

(A) **V109** IS A BI-STABLE MULTIVIBRATOR WHOSE OUTPUTS ARE USED TO:

(1) CLAMP THE TRIANGLE INTEGRATOR GRID (PIN #2 OF V102A) NEAR GROUND LEVEL WHICH STOPS OPERATION OF THE GENERATING CIRCUITS, V105, V101B AND V102B.

(2) PROVIDE A TRIGGER OUT PULSE AND A GATE TO V108 IN EXTERNAL TRIGGER OPERATION.

(B) WHEN THE TRIGGER SWITCH IS IN THE EXTERNAL POSITION, THE FIRST NEGATIVE-GOING PORTION OF THE SQUARE WAVE AT PIN #7 OF V109 WILL TURN OFF THAT SIDE OF THE TUBE. THIS WILL STOP ALL INTERNAL TRIGGERING DUE TO THE CLAMP ACTION AT GRID PIN #2 OF V102A. THE NEGATIVE GOING PORTION OF AN EXTERNAL OR MANUAL TRIGGER AT PIN #2 OF V109 WILL CAUSE THAT HALF OF THE TUBE TO CUT OFF. V109B WILL CONDUCT AND THE CLAMP WILL BE REMOVED. OPERATION WILL CONTINUE FOR ONE CYCLE UNTIL THE FALLING EDGE OF THE SQUARE WAVE AGAIN LOCKS OUT V109.

2.4 TROUBLESHOOTING PROCEDURE

2.4.1 POWER SUPPLY

(A) ALL CIRCUITS DEPEND ON THE REGULATED -210V, +100V AND +250V. THE MORE CRITICAL GENERATING CIRCUITS ALSO DEPEND ON THE -11V FILAMENT REGULATION. ALWAYS CHECK THESE SUPPLIES FOR PROPER VOLTAGE AND BELOW 10MV OF RIPPLE (100MV ON -11V SUPPLY).

(1) FOR -210V PROBLEMS CHECK V1, V2 AND V3; CHECK -210 ADJ R23; CHECK DIODES D9 THROUGH D12.

(2) FOR +100V PROBLEMS CHECK -210V, V3 AND V4, DIVIDER VOLTAGE AT PIN 1 OF V4 AND DIODES D5 THROUGH D8.

(3) FOR +250V PROBLEMS CHECK -210V, V5 AND V6, DIVIDER VOLTAGE AT PIN 1 OF V6 AND DIODES D1 THROUGH D4.

(4) FOR -11V PROBLEMS CHECK Q1, Q2, ZENER DIODE D17 AND DIODES D13 THROUGH D16.

2.4.2 SQUARE WAVE

V105 GENERATES THE SQUARE WAVE AND ALSO GATES THE TRIANGLE MILLER INTEGRATOR V102. PROBLEMS INVOLVING SQUARE WAVE ONLY SHOULD BE TRACED TO V101 AND V105 IN THAT ORDER.

2.4.3 TRIANGLE

V102 IS A MILLER INTEGRATOR AND PRODUCES A POSITIVE AND NEGATIVE GOING VOLTAGE IN THE FORM OF A TRIANGLE WHICH IS FED BACK TO V105 TO DETERMINE THE FLIPPING TIME OF THE MULTIVIBRATOR. PROBLEMS INVOLVING TRIANGLE ONLY SHOULD BE TRACED TO V103A, V102, R188 AND R161 SETTINGS IN THAT ORDER.

2.4.4 SINE

V104 SHAPES THE TRIANGLE WAVE INTO A SINE WAVE. THE SHAPING OF THE SINE WAVE DEPENDS ON ACCURATE SYMMETRY OF THE SQUARE WAVE AND TRIANGLE, AS WELL AS CORRECT INPUT LEVEL AND AMPLITUDE OF TRIANGLE.

ALL PREVIOUS SETTINGS AND CALIBRATION PROCEDURES SHOULD BE CHECKED BEFORE FURTHER TROUBLESHOOTING THE SINE WAVE. AFTER DOING THIS, TRACE PROBLEM TO V103A, V107, SINE SHAPE ADJUSTMENTS (R185, R193, R202) AND SINE DC LEVEL R208 IN THAT ORDER.

2.4.5 RAMP

V108 IS TRIGGERED BY V105 (INTERNAL TRIGGERING) OR V109 (EXTERNAL TRIGGERING) AND FURNISHES THE GATE FOR MILLER INTEGRATOR V107. PROBLEMS INVOLVING RAMP ONLY SHOULD BE TRACED TO V106B, V107, V108, RAMP LEVEL AND RAMP LENGTH POTENTIOMETER (R121 AND R123) SETTINGS, AND D102 AND D103 IN THAT ORDER.

2.4.6 MULTIPLE PROBLEMS

(A) SQUARE WAVE SYMMETRY ADJUSTMENTS WOULD CAUSE MALFUNCTION OF TRIANGLE AND SINE.

(B) EXTERNAL TRIGGER TUBE V109, HOLD-OFF LEVEL R151 AND DIODE D105 COULD ALL CAUSE LACK OF, OR IMPROPER, EXTERNAL TRIGGERING.

(C) THE LACK OF A MAIN OUTPUT COULD BE CAUSED BY V106A OR THE ± DC LEVEL SWITCH SW105 OR POTENTIOMETER R131.

2.5 RESISTANCE AND DC VOLTAGE CHARTS

2.5.1 POWER SUPPLY RESISTANCE AND DC VOLTAGE CHART

(A) RESISTANCE MEASUREMENTS

THE RESISTANCE MEASUREMENTS WERE MADE ON A COLD INSTRUMENT WITH THE INSTRUMENT CONTROLS SET AS FOLLOWS:

2.5.1 Power Supply Resistance and DC Voltage Chart

(a) (continued)

MULTIPLIER	100
CYCLES/SEC dial	10
ATTENUATOR	Full CW
POWER OFF-ON	Off
TRIGGER	Internal

(b) DC voltage Measurements

1. The DC Voltage measurements were made with a VTVM having an 11 megohm input resistance. The instrument input voltage was adjusted to 117 VAC.

2. The function generator controls were set as follows:

MULTIPLIER	100
CYCLES/SEC dial	10
ATTENUATOR	Full CW
POWER OFF-ON	On
TRIGGER	Internal

2.5.2 MAIN CHASSIS RESISTANCE AND DC VOLTAGE CHART

(a) Resistance Measurements

The resistance measurements were made on a cold instrument with the instrument controls set as follows:

MULTIPLIER	100
CYCLES/SEC dial	10
ATTENUATOR	Full CW
POWER OFF-ON	On
TRIGGER	Internal

(b) DC Voltage Measurements

1. The DC Voltage measurements were made with a VTVM having an 11 megohm input resistance. The instrument input voltage was adjusted to 117 VAC.

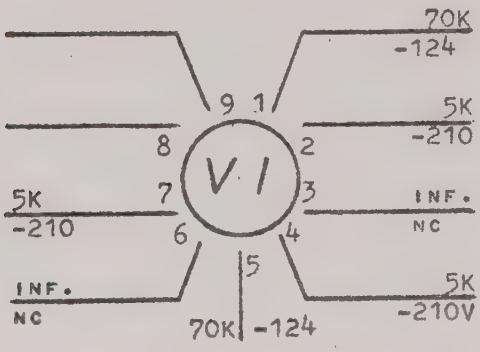
2. The function generator controls were set as follows:

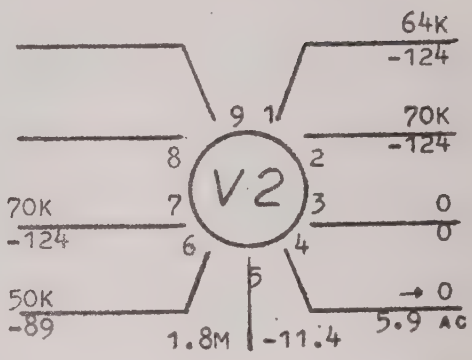
MULTIPLIER	100
CYCLES/SEC dial	10
ATTENUATOR	Full CW
POWER OFF-ON	On
TRIGGER	Internal

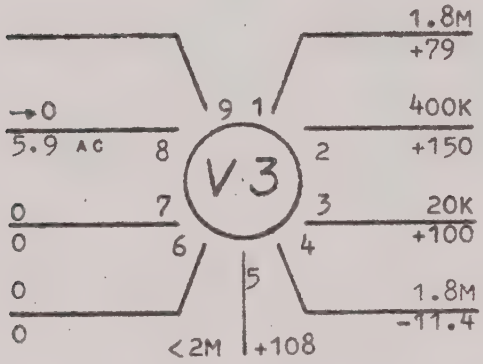
2.6 WAVEFORM AMPLITUDE AND DC LEVEL CHART

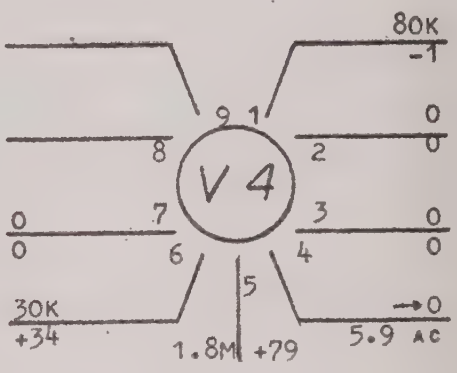
The waveform amplitudes and DC levels were measured using a Tektronix Type 532 Oscilloscope with a Type CA Dual Trace Plug-in. The function generator controls were set as listed in paragraph 2.5.2 (a) and (b).

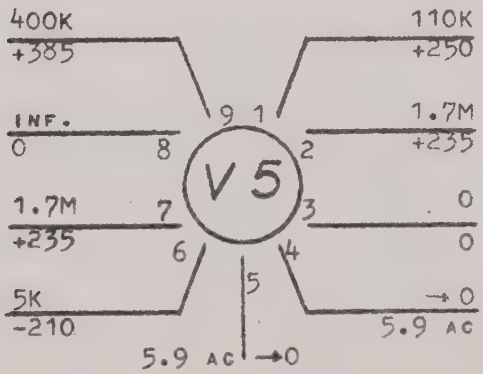
POWER SUPPLY DC VOLTAGE AND RESISTANCE CHART

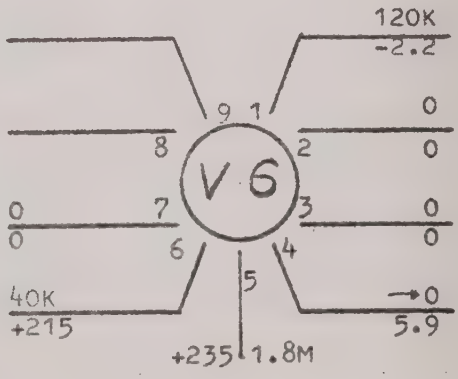


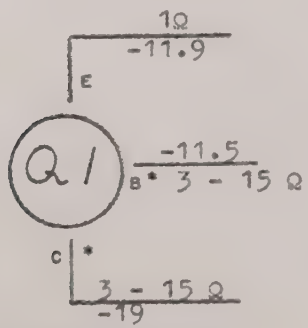


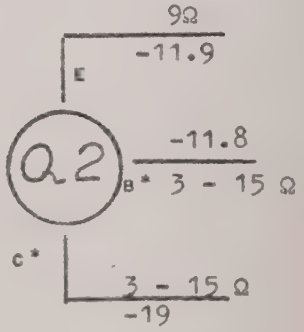






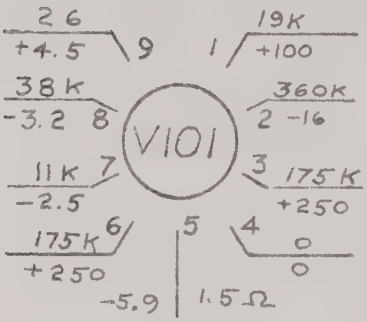


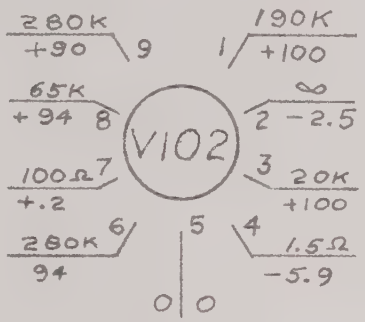


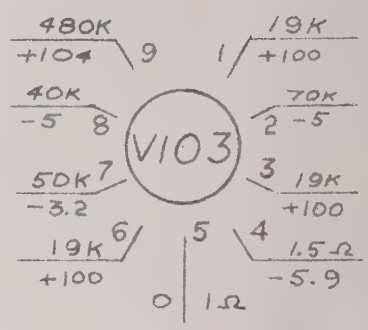


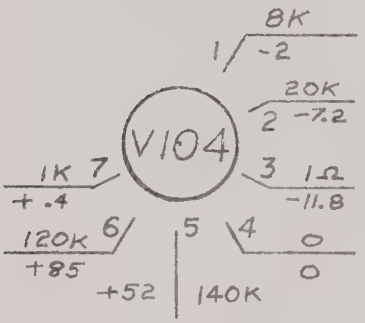
*DEPENDS ON METER POLARITY

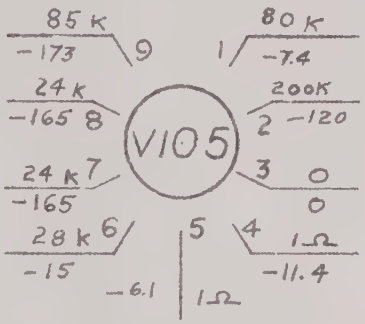
MAIN CHASSIS DC VOLTAGE AND RESISTANCE CHART

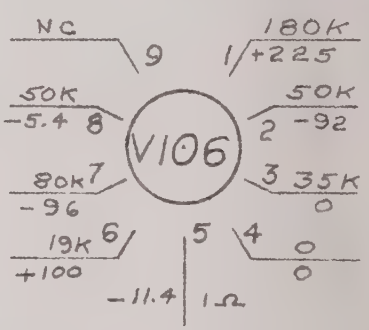


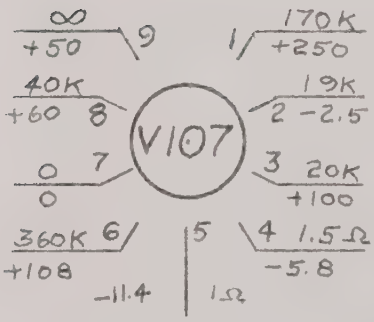


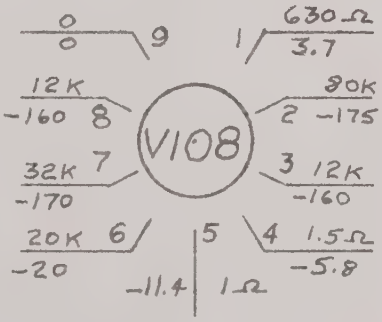


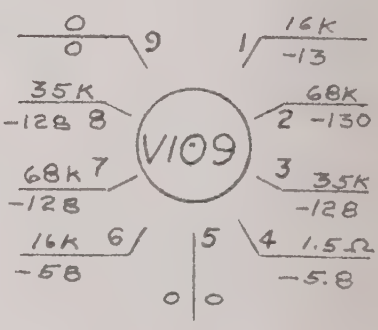


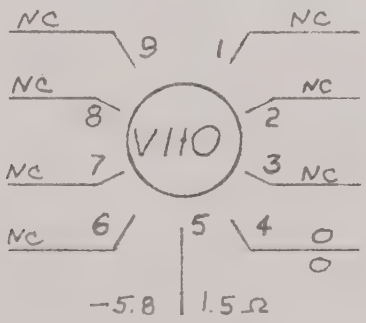




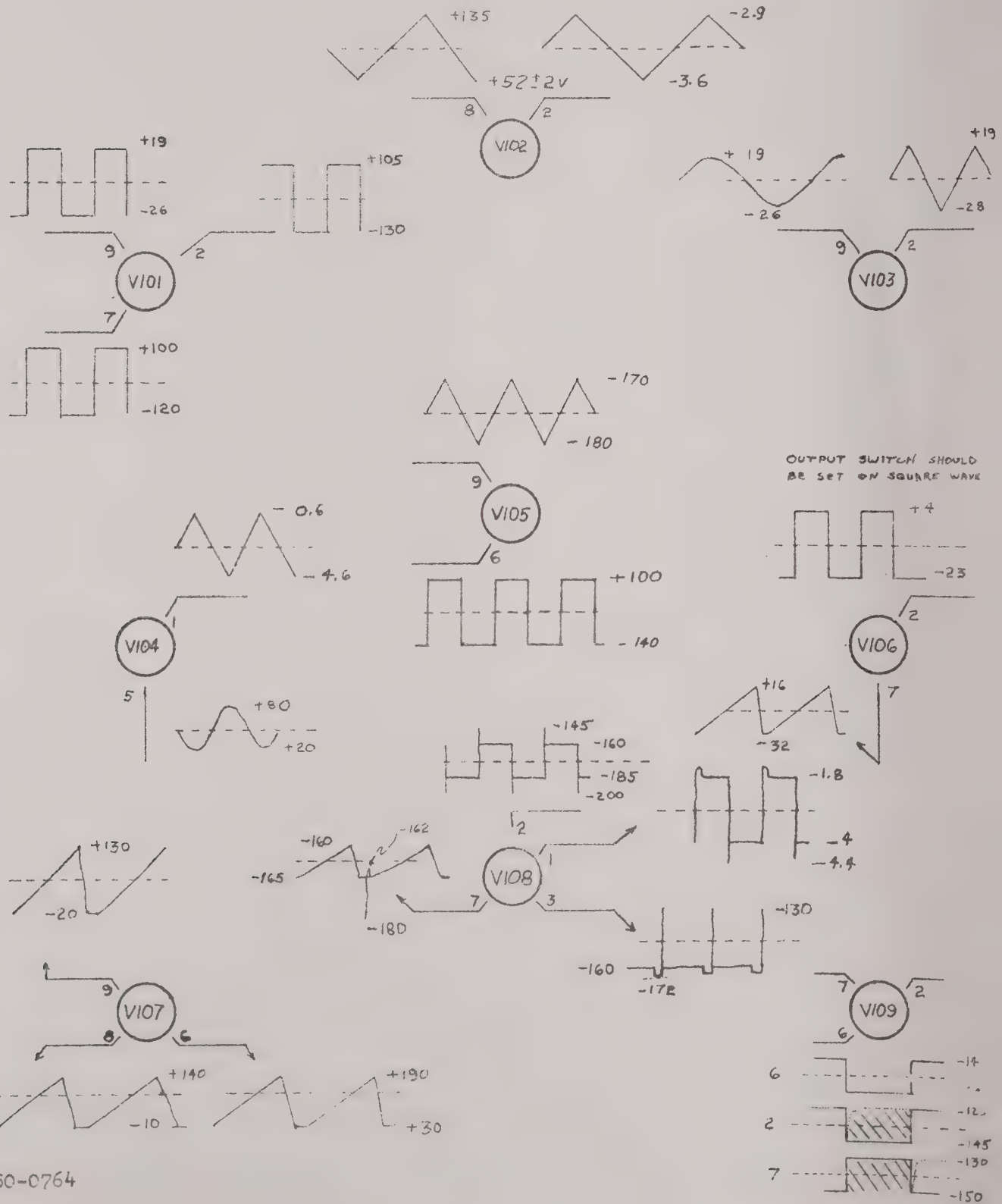








MAIN CHASSIS WAVEFORM AMPLITUDE AND DC LEVEL CHART



SECTION III CALIBRATION

3.1 - POWER SUPPLY

3.1.1 Preliminary Settings and Adjustments
3.1.2 Power Supply Resistance Checks
3.1.3 Power Supply Voltage Checks
3.1.4 Power Supply Regulation
3.1.5 Power Supply Ripple Checks

3.2 - TIMING

3.2.1 Preliminary Settings and Adjustments
3.2.2 Triangle Balance
3.2.3 Preliminary Timing
3.2.4 Square Wave Symmetry
3.2.5 Final Timing
3.2.6 Final Function Generator Timing Check

3.3 - TRIANGLE LINEARITY

3.3.1 Preliminary Settings and Adjustments
3.3.2 Linearity Check (100 cycles/sec)
3.3.3 Linearity Check (10 cycles/sec)
3.3.4 Verification of Linearity

3.4 - SINE-WAVE CALIBRATION

3.4.1 Preliminary Settings and Adjustments
3.4.2 Final Sine Wave Adjustments

3.5 - RAMP WAVE CALIBRATION

3.5.1 Preliminary Settings and Adjustments
3.5.2 Ramp Wave Calibration

3.6 - - - - - - - - - - - - - - - - DC LEVELS AND OUTPUT AMPLITUDE

3.6.1 Preliminary Settings and Adjustments
3.6.2 Sine Wave DC Level and Amplitude Measurement
3.6.3 Triangle Wave DC Level and Amplitude
3.6.4 Square Wave DC Level and Amplitude

3.7 - INPUT TRIGGER CHECKS

3.7.1 Preliminary Settings and Adjustments
3.7.2 Single Shot Trigger Tests
3.7.3 External Trigger Tests

CAUTION COVERS MUST BE IN PLACE DURING FINAL CALIBRATION

CALIBRATION PROCEDURE

THE FOLLOWING TEST EQUIPMENT OR SUITABLE EQUIVALENTS OF KNOWN ACCURACY ARE REQUIRED FOR COMPLETE CALIBRATION OF THE TYPE 250 FUNCTION GENERATOR.

1.	MULTIMETER	TRIPLETT MODEL 630
2.	OSCILLOSCOPE	TEKTRONIX 503
3.	DISTORTION ANALYZER	HEWLETT PACKARD 330B
4.	AUTO TRANSFORMER	GENERAL RADIO TYPE M5

3.1 POWER SUPPLY

3.1.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) PLACE A STRAP BETWEEN THE CHAS GRD AND CKT GRD.

(B) SET THE MULTIPLIER SWITCH TO .001 AND THE CYCLES/SEC DIAL TO X1.

3.1.2 POWER SUPPLY RESISTANCE CHECKS

USING THE MULTIMETER, VERIFY THAT THE POWER SUPPLY RESISTANCES ARE SPECIFIED BELOW

-210 VOLT SUPPLY APPROXIMATELY 5,000Ω
+250 VOLT SUPPLY APPROXIMATELY 60,000Ω MIN.
+100 VOLT SUPPLY APPROXIMATELY 19,000Ω

3.1.3 POWER SUPPLY VOLTAGE CHECKS

(A) CONNECT THE FUNCTION GENERATOR THROUGH THE VARIAC TO 117V, 60CPS.

(B) USING THE MULTIMETER, VERIFY THAT THE POWER SUPPLY VOLTAGES ARE AS SPECIFIED BELOW

-210 VOLT SUPPLY	-210VDC (ADJUSTABLE)
+100 VOLT SUPPLY	+100 ±5VDC
+250 VOLT SUPPLY	+250 ±13VDC
- 11 VOLT SUPPLY	- 11 ±1.1VDC

3.1.4 POWER SUPPLY REGULATION

VERIFY THAT ALL SUPPLIES REGULATE AS THE INPUT VOLTAGE IS VARIED FROM 105 TO 125 VAC.

3.1.5 POWER SUPPLY RIPPLE CHECK

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	MAX.
INPUT COUPLING	AC
SWEEP TIMING	10 MSEC/CM
TRIGGER	CONTINUOUSLY RUNNING

3.1.5 POWER SUPPLY RIPPLE CHECK (CONTINUED)

(B) AT THE FUNCTION GENERATOR REMOVE V105.

(C) USING THE OSCILLOSCOPE, VERIFY THAT RIPPLE VOLTAGES DO NOT EXCEED THE VOLTAGE SPECIFIED FOR EACH SUPPLY LISTED BELOW:

-210 VOLTS	10MV MAX.
+100 VOLTS	10MV MAX.
+250 VOLTS	10MV MAX.
- 11 VOLTS	100MV MAX.

(D) AT THE FUNCTION GENERATOR REPLACE V105.

3.2 TIMING

3.2.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MULTIPLIER SWITCH	10

(B) CHECK THE CYCLES/SEC DIAL FOR MECHANICAL CENTER AND SET TO X10.

(C) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	1 V/CM
INPUT COUPLING	DC
SWEEP TIMING	10 MSEC/CM
TRIGGER	EXTERNAL

3.2.2 TRIANGLE WAVEFORM BALANCE

THE INSTRUMENT SHOULD BE ON AT LEAST 15 MINUTES BEFORE ANY OF THE FOLLOWING ADJUSTMENTS ARE MADE.

CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO PIN #8 OF V102 AND ADJUST THE MILLER DC BAL R188 UNTIL THE BOTTOM OF THE TRIANGLE WAVEFORM IS AT +52 ±2V. THE AMPLITUDE OF THE WAVEFORM AT THIS LEVEL WILL VARY SLIGHTLY FROM INSTRUMENT TO INSTRUMENT. HOWEVER THE MOST IMPORTANT SETTING IS TO HAVE THE NEGATIVE PEAK OF THE TRIANGLE WAVEFORM AT +52 ±2V.

3.2.3 PRELIMINARY TIMING

(A) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE TRIANGLE WAVEFORM OUTPUT TERMINAL. SET THE VERTICAL SENSITIVITY TO 10 V/CM.

3.2.3 Preliminary Timing (continued)

(b) Connect the trigger input of the oscilloscope to the function generator EXT TRIG OUT.

(c) Adjust the MAIN TIMING ADJ R161 and verify that ten triangles appear for 10 cm of sweep on the oscilloscope.

3.2.4 Square Wave Symmetry

(a) Set the oscilloscope controls as follows:

VERTICAL SENSITIVITY	10 v/cm
INPUT COUPLING	DC
SWEEP TIMING	1 msec/cm
TRIGGER	Internal

(b) Connect the vertical amplifier of the oscilloscope to the Square Wave output terminal of the function generator. Adjust the oscilloscope triggering so that a change from plus to minus internal triggering will cause a stationary polarity reversal of one cycle of the square wave.

(c) Position the rise or fall of the Square Wave to the center of the graticule and turn the oscilloscope MAGNIFIER to ON.

(d) While switching the oscilloscope trigger between plus and minus internal triggering, adjust the SQUARE SYMMETRY (X10) R173 for no shift in the waveform (equal positive and negative portions referenced to time).

(e) Set the function generator CYCLES/SEC dial to X1, the MULTIPLIER to 100 and the oscilloscope sweep to 1 msec/cm.

(f) Repeat the procedure in 3.2.4 (d) adjusting the SQUARE SYMMETRY (X1) R177 for no shift in the waveform.

3.2.5 Final Timing

(a) Set the function generator controls as follows:

MULTIPLIER	10
CYCLES/SEC dial	10

(b) Set the oscilloscope controls as follows:

VERTICAL SENSITIVITY	10 v/cm
INPUT COUPLING	DC
SWEEP TIMING	10 msec/cm
TRIGGER	External (negative)
MAGNIFIER	Off

3.2.5 Final Timing (continued)

(c) Connect the vertical amplifier of the oscilloscope to the Triangle Waveform output terminal of the function generator.

(d) Recheck the timing, and if necessary, readjust the MAIN TIMING ADJ (paragraph 3.2.3 (c)).

R161

(e) Adjust the CYCLES/SEC dial towards 1, until 1 Triangle appears for 10 cm of sweep on the oscilloscope.

(f) Observe the amount of error at this end of the dial. Loosen the set screw and mechanically shift the dial to compensate for the error. Snub the set screw but do not lock.

NOTE: R111A (CYCLES/SEC variable resistor) is very sensitive at the X1 end; therefore care must be taken when this setting is made.

(g) Adjust the CYCLES/SEC dial of the function generator toward 10 until 10 triangles appear for 10 cm of sweep on the oscilloscope.

(h) Observe the amount of error at this end of the dial. If there is less than 2%, lock the set screws.

(j) Set the oscilloscope sweep timing to 100µsec, the function generator MULTIPLIER to 1000 and the CYCLES/SEC dial to X1.

(k) Adjust the 1000 cycles Timing Capacitor C119A for 1 triangle in 10 cm of scope sweep.

(l) Set the function generator CYCLES/SEC dial to 10. Adjust high frequency compensation trimmer capacitor C122 for 10 triangles in 10 cm of scope sweep.

(m) Repeat (j), (k) and (l) as necessary so that both ends of the dial are accurate.

3.2.6 Final Function Generator Timing Check

(a) High Frequency Timing Check

1. Set the oscilloscope SWEEP TIMING to 10µsec, the function generator MULTIPLIER switch to X1000 and the CYCLES/SEC dial to 10.

2. Verify that the function generator is correctly timed at 10,000 cycles per second by observing one cycle of the Triangle Waveform for 10 cm of sweep on the oscilloscope.

3.2.6 Final Function Generator Timing Check

(a) (continued)

3. Set the oscilloscope SWEEP TIMING to 100μsec/cm, the function generator MULTIPLIER switch to 1000, and the CYCLES/SEC dial to X1.

4. Verify that the function generator is correctly timed at 1000 cycles per second by observing one cycle of the Triangle Waveform for 10 cm of sweep on the oscilloscope.

(b) Mid Frequency Timing Check

1. Set the oscilloscope SWEEP TIMING to 100μsec/cm, the function generator MULTIPLIER switch to 100 and the CYCLES/SEC dial to X10.

2. Verify that the function generator is correctly timed at 1000 cycles per second by observing one cycle of the Triangle Waveform for 10 cm of sweep on the oscilloscope.

3. Set the oscilloscope SWEEP TIMING to 1 msec/cm, the function generator MULTIPLIER switch to 100 and the CYCLES/SEC dial to X1.

4. Verify that the function generator is correctly timed at 100 cycles per second by observing one cycle of the Triangle Waveform for 10 cm of sweep on the oscilloscope.

(c) Low Frequency Timing Check

1. Set the oscilloscope SWEEP TIMING to 10 msec/cm, the function generator MULTIPLIER switch to 1 and the CYCLES/SEC dial to X10.

2. Verify that the function generator is correctly timed at 10 cycles per second by observing one cycle of the Triangle Waveform for 10 cm of sweep on the oscilloscope.

3. Set the oscilloscope SWEEP TIMING to 100 msec/cm, the function generator MULTIPLIER switch to 1 and the CYCLES/SEC dial to X1.

4. Verify that the function generator is correctly timed at 1 cycle per second by observing one cycle of the Triangle Waveform for 10 cm of sweep on the oscilloscope.

(d) Repeat steps 3.2.6 (c) 1 through 4 for frequencies .1, .01 and .001.

3.3 TRIANGLE LINEARITY

NOTE: IN THIS CHECK IT IS VERY IMPORTANT THAT AN OSCILLOSCOPE WHOSE CRT GEOMETRY AND LINEARITY ARE CALIBRATED TO 1/2%, OR BETTER, BE USED IN THIS TEST. (CHECK THE OSCILLOSCOPE LINEARITY BY OBSERVING THE OSCILLOSCOPE'S SAWTOOTH OUT.)

3.3.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10 V/CM
SWEEP TIMING	0.5 MSEC/CM
INPUT COUPLING	DC
TRIGGER	EXTERNAL (NEGATIVE)

(B) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MULTIPLIER	10
CYCLES/SEC DIAL	10

3.3.2 LINEARITY CHECK (100 CYCLES/SEC)

(A) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE TRIANGLE WAVE OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(B) ADJUST THE VERTICAL GAIN AND THE SWEEP VERNIER OF THE OSCILLOSCOPE TO DISPLAY ONLY THE RISING HALF CYCLE OF TRIANGLE WAVEFORM OVER THE ENTIRE GRATICULE AREA.

(C) OBSERVE THE LINEARITY OF THE WAVEFORM.

(D) SET THE OSCILLOSCOPE TRIGGERING TO EXTERNAL (POSITIVE).

(E) OBSERVE THE LINEARITY OF THE FALLING HALF CYCLE OF THE TRIANGLE WAVEFORM OCCUPYING THE ENTIRE GRATICULE AREA.

3.3.3 LINEARITY CHECK (10 CYCLES/SEC)

(A) SET THE OSCILLOSCOPE SWEEP TIMING TO 5.0 MSEC/CM AND THE FUNCTION GENERATOR CYCLES/SEC DIAL TO X1.

(B) REPEAT PARAGRAPH 3.3.2 (A) THROUGH (E) AT THE X1 END OF THE CYCLES/SEC DIAL.

3.3.4 VERIFY THAT THE NON-LINEARITY IS LESS THAN 1% THROUGHOUT THE TESTS IN PARAGRAPH 3.3.2 (A) THROUGH 3.3.3 (B).

NOTE: IF THE NON-LINEARITY IS APPROACHING 1%, TRY CHANGING V102 AND REPEAT CALIBRATION PARAGRAPHS 3.2.1 THROUGH 3.2.5.

3.4 SINE WAVE CALIBRATION

NOTE: THE PURENESS OF THE SINE WAVE WILL DEPEND ON THE ACCURACY OF THE PROCEEDING ADJUSTMENTS. ANY SUBSEQUENT CHANGES OR RECALIBRATION OF PREVIOUS STEPS WILL MAKE IT NECESSARY THAT SINE CALIBRATION BE RECHECKED.

3.4.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	10 v/cm
SWEEP TIMING	2 TO 5 msec/cm
INPUT COUPLING	DC
TRIGGER	EXT.

(B) SET THE CONTROLS OF THE FUNCTION GENERATOR AS FOLLOWS:

MULTIPLIER	10
CYCLES/SEC DIAL	10

(C) CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO THE SINE WAVE OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

(D) SHAPE THE SINE WAVE AS FOLLOWS:

1. ADJUST C SINE SHAPE R202 FULLY CCW (GROUND).

2. USING FIGURES 1 THROUGH 5 WITH THEIR RESPECTIVE NOTES, ADJUST A SINE SHAPE AND B SINE SHAPE (R185 AND R193) FOR THE BEST SINE WAVE POSSIBLE.

NOTE: THESE ADJUSTMENTS ARE VERY INTERDEPENDENT AND ONE CAN BE AT A SETTING WHERE IT IS IMPOSSIBLE FOR THE OTHER TO CORRECT. B SINE SHAPE CONTROLS MORE OF THE AMPLITUDE AND A SINE SHAPE CONTROLS MORE OF THE SHAPE ITSELF. IT IS BEST TO SET B FOR NEARLY MAXIMUM AMPLITUDE, THEN AS A IS ADJUSTED B CAN BE REDUCED IN AMPLITUDE TO MAINTAIN PROPER SHAPE. THIS IS AN OPTIMUM WAVE SHAPE AT THIS POINT.

3. ADJUST C SINE SHAPE TO ROUND THE BOTTOM OF THE SINE WAVE. A AND B SINE SLOPES MAY BE READJUSTED FOR FINAL SMOOTHING.

3.4.2 FINAL SINE WAVE ADJUSTMENTS

(A) CONNECT THE DISTORTION ANALYZER INPUT TO THE SINE WAVE OUTPUT TERMINAL OF THE FUNCTION GENERATOR.

3.4.2 Final Sine Wave Adjustments (continued)

(B) Carefully adjust SINE SHAPE A, B AND C for minimum harmonic distortion.

(C) Verify that the total harmonic distortion at 1KC is less than 1%.

(D) Verify that the total harmonic distortion at 10KC is less than 2%.

NOTE 1: If the above specifications cannot be met, changing of V104 and repeating calibration paragraphs 3.4.1 through 3.4.2 (B) should be accomplished.

NOTE 2: If a waveform analyzer is used in place of a distortion analyzer, the first 10 harmonics should be checked with adjustments made considering the first 5.

3.5. RAMP WAVEFORM CALIBRATION

3.5.1 Preliminary Settings and Adjustments

(A) Set the oscilloscope controls as follows:

VERTICAL SENSITIVITY	Approx. 10 v/cm
SWEEP TIMING	1 msec/cm
INPUT COUPLING	DC
TRIGGER	EXTERNAL

(B) Set the function generator controls as follows:

MULTIPLIER	100
CYCLES/SEC dial	10
TRIGGER SOURCE	INTERNAL
OUTPUT ATTEN	Full CW

3.5.2 Ramp Waveform Calibration

(A) With the test oscilloscope on the RAMP output, rough adjust RAMP LENGTH R123 and RAMP DC LEVEL R121 for a stable pattern DC balanced around ground. Fine adjust RAMP LENGTH R123 for a "HOLD OFF" time of about 10% at the end of each ramp. This is normal and it is there to allow the ramp to fall and re-establish DC level before rising again and to assure positive synchronization to the square waveform generator.

Fine adjust RAMP DC LEVEL R121 for center DC ground.

3.5.2 RAMP WAVE CALIBRATION (CONTINUED)

(B) SET THE FUNCTION GENERATOR MULTIPLIER TO 1000 AND OSCILLOSCOPE SWEEP TIME TO 100 µSEC/CM.

(C) ADJUST TIMING CAPACITOR C105A FOR 10 CYCLES IN 20 CM. (NOTE START OF RAMP AND READJUST IF NOT LINEAR.)
C105 Affects Hold off. Not Time

(D) CHANGE FUNCTION GENERATOR CYCLES/SEC DIAL TO X1 AND OSCILLOSCOPE SWEEP TIME TO 1 MSEC/CM.

(E) VERIFY THAT THE "HOLD OFF" TIME IS NO MORE THAN 10% OF TOTAL PERIOD.

NOTE: AT X1 END OF THE RAMP TIMING POTENTIOMETER R111B, THE VALUE OF THE GROUND RETURN RESISTOR R110 IS A NOMINAL VALUE AND IS CHOSEN FOR MAINTAINING PROPER "HOLD OFF" AT THIS POINT.

3.6 DC LEVELS AND OUTPUT AMPLITUDE

3.6.1 PRELIMINARY SETTINGS AND ADJUSTMENTS

(A) SET THE OSCILLOSCOPE CONTROLS AS FOLLOWS:

VERTICAL SENSITIVITY	APPROX. 5 V/CM
SWEEP TIMING	10 MSEC/CM
INPUT COUPLING	DC
TRIGGER	EXTERNAL

(B) SET THE FUNCTION GENERATOR CONTROLS AS FOLLOWS:

MULTIPLIER	10
CYCLES/SEC DIAL	10

(C) CALIBRATE THE OSCILLOSCOPE AS FOLLOWS:

1. CONNECT THE VERTICAL AMPLIFIER OF THE OSCILLOSCOPE TO A CALIBRATED SIGNAL SOURCE (BUILT IN OSCILLOSCOPE CALIBRATOR).

2. SET THE CALIBRATOR OUTPUT FOR 10 VPP.

3. ADJUST THE VERTICAL GAIN OF THE OSCILLOSCOPE, CALIBRATE THE OSCILLOSCOPE SO THAT 40 VPP IS EQUAL TO 4 CM DEFLECTION.

4. GROUND THE INPUT OF THE VERTICAL AMPLIFIER AND USING THE VERTICAL POSITIONING CONTROL OF THE OSCILLOSCOPE SET THE SWEEP EXACTLY ON THE VERTICAL CENTER LINE OF THE GRATICULE.

3.6.1 Preliminary Settings and Adjustments

(c) (continued)

NOTE: The oscilloscope is now calibrated to display a waveform of 40 VPP/4cm with the DC ground control on the center of the graticule.

DO NOT TOUCH THE VERTICAL CONTROLS OF THE OSCILLOSCOPE DURING THE FOLLOWING PROCEDURE.

(d) At the function generator adjust the ATTENUATOR to full CCW and connect the multimeter between ground and the MAIN OUTPUT TERMINAL.

(e) Adjust the MIN AMP DC BALANCE R134 for 0 volts as indicated by the multimeter. Remove meter.

3.6.2 Sine Wave DC Level and Amplitude Measurement

(a) Connect the vertical amplifier of the oscilloscope to the MAIN output terminal of the function generator.

(b) Set the function generator ATTENUATOR to full CW.

(c) With the OUTPUT selector switch set to SINE, accurately measure and record the PP amplitude of the Sine wave.

(d) Connect the multimeter between the MAIN output and ground. The multimeter should be set on the 10 VDC scale.

(e) Adjust SINE DC LEVEL R208 for zero indication on meter. Increase meter sensitivity as needed.

3.6.3 Triangle Wave DC Level and Amplitude

(a) Repeat paragraph 3.6.2 (a) and (b).

(b) With the OUTPUT selector switch set to TRIANGLE and using TRIANGLE AMP ADJ R205, set the Triangle amplitude equal to that of the Sine wave.

(c) Connect the multimeter between the MAIN output and ground. The multimeter should be set on the 10 VDC scale.

(d) Adjust TRIANGLE DC LEVEL R191 for zero indication on the meter. Increase meter sensitivity as needed.

3.6.4 Square Wave DC Level and Amplitude

(a) Repeat paragraph 3.6.2 (a) and (b).

3.6.4 Square Wave DC Level and Amplitude (continued)

(b) With the OUTPUT selector switch set to SQUARE and using SQUARE AMP ADJ R165, set the square amplitude equal to that of the sine wave.

(c) Connect the multimeter between the MAIN output and ground. The multimeter should be set on the 10 VDC scale.

(d) Adjust SQUARE DC LEVEL R167 for zero indication on the meter. Increase meter sensitivity as needed.

3.7 INPUT TRIGGER CHECKS

3.7.1 Preliminary Settings and Adjustments

(a) Set the oscilloscope controls as follows:

VERTICAL SENSITIVITY	10 v/cm
SWEEP TIMING	.5 msec/cm
INPUT COUPLING	DC
TRIGGER	EXTERNAL

(b) Set the function generator controls as follows:

MULTIPLIER	1000
CYCLES/SEC dial	10
OUTPUT	TRIANGLE
TRIGGER	EXTERNAL

3.7.2 Single Shot Trigger Tests

(a) Connect the vertical amplifier of the oscilloscope to the MAIN output terminal of the function generator.

(b) Push the MANUAL trigger push button and observe the waveform on the oscilloscope. Adjust HOLD OFF DC LEVEL (R151) until the generated waveform starts and stops at zero DC reference.

(c) Verify that a single waveform is generated for each applied manual trigger.

(d) Repeat (a) through (c) above for each position of the OUTPUT selector switch.

3.7.3 External Trigger Tests

(a) Connect the EXTERNAL TRIGGER terminal of the function generator to an external trigger source of at least 15V with a frequency of approximately 1KC (i.e. oscilloscope calibrator out) and observe the waveform on the oscilloscope.

3.7.3 External Trigger Tests (continued)

(b) Verify that the output waveform is triggered at a repetition rate equal to that of the trigger source.

(c) Repeat (a) and (b) above for each position of the OUTPUT selector switch.

FIGURE 1
SINE ADJ B ABOUT CORRECT, BUT SINE ADJ A TOO FAR CW. ROTATE "A" CCW UNTIL BOTTOM IS LESS FLAT AND TOP MORE FULL AND ROUND.

FIGURE 2
SINE ADJ B TOO FAR CCW. ROTATE CW UNTIL TOP IS PROPER SHAPE. IF BOTH TOP AND BOTTOM ARE FLAT, REDUCE AMPLITUDE WITH SINE ADJ B (CW ROTATION) AND ADJUST "A" TO RE-CENTER WAVEFORM (SYMMETRICAL SHAPE).

FIGURE 3
NOT ENOUGH ADJUSTMENT OF EITHER "A" OR "B". INCREASE AMPLITUDE (CW) WITH SINE ADJ B AND ADJUST "A" CW TO RE-CENTER WAVEFORM.

FIGURE 4
APPROXIMATELY OPTIMUM SETTING OF "A" AND "B" AND NOW AN ADJUSTMENT OF SINE ADJ C WILL ROUND THE BOTTOM OF THE WAVEFORM PROPERLY.

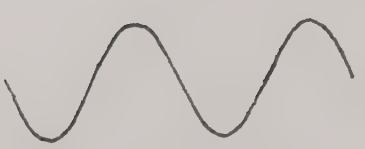


FIGURE 5
SINE ADJ C MADE PROPERLY. OPTIMUM SINE WAVEFORM.

THE "B" ADJUSTMENT ADDS SIGNAL TO THE SHAPING CIRCUIT; CCW ROTATION CAUSES FLATTENING, CW ROTATION CAUSES THE SINE WAVE TO APPROACH A TRIANGLE WAVE. "A" ADJUSTMENT CONTROLS DC LEVEL AND RE-CENTERS THE WAVEFORM. "C" ADJUSTMENT SERVES TO SHAPE ONLY THE BOTTOM OF THE WAVEFORM.

SECTION IV

PARTS LIST

ABBREVIATIONS USED IN OUR PARTS LIST

Cer.	ceramic	μμ	micromicro
Comp	composition	m	milli
EMC	electrolytic, metal cased	Prec	precision
EMT	electrolytic, metal tubular	PT	paper tubular
fd	farad	Tub.	tubular
h	henry	v	working volts DC
k	thousands of ohms	Var	variable
meg	megohms	w	watt
MF	metal film	WW	wire wound
μ	micro	PF	pico farad

The column preceding the parts numbers contains the abbreviations of the manufacturers from whom we purchase the specified part. These abbreviations are listed below.

AB	Allen Bradley
AMX	Amperex
BB	Birnbach
BNS	Bourns
CD	Continental Device Corp.
CL	Clarostat
CLR	Centralab
CNG	Corning Resistor
CR	Claro Resistor
CW	Continental-Wirt
DE	Delco
DI	Diodes Inc.
ER	Erie Technological Products
EX	Exact Electronics Inc.
GE	General Electric Co.
GR	Grayhill
IRC	International Resistance Corp.
LF	Littlefuse
MA	Mallory
MTR	Motorola
OAK	Oak Electronics Corp.
PEN	Penn Resistor Corp.
RCA	Radio Corp. of America
RMC	Radio Materials Co.
SG	Signalite
SPR	Sprague Electric
SPE	Spectrol
SR	Sartron Inc.
ST	Sarkes Tarzian Inc.
TI	Texas Instruments
TJ	Tobias Jensen
TS	Tung-Sol
WH	Westinghouse
WL	Ward Leonard

250 POWER SUPPLY

BULBS

B1	#12	6 v				GE	150018

CAPACITORS

C1	80 ufd	500 v	EMC			SPR	290028
C2 A&B	20/20 ufd	450 v	EMC			SPR	290009
C3	80 ufd	500 v	EMC			SPR	290028
C4 A&B	20/20 ufd	450 v	EMC			SPR	290009
C5 A&B	20/20 ufd	450 v	EMC			SPR	290009
C6	.01 ufd	400 v			10%	AMX	285203
C7	.01 ufd	400 v			10%	AMX	285203
C8	.01 ufd	400 v			10%	AMX	285203
C9	2000 ufd	20 v	EMC			SPR	290029

DIODES

D1-D12	IN3194	RCA	152016
D13-D16	IN1217	WH	152005
D17	ZA12B Zenner	MA	152022

FUSES

F1	2A 3AG	LF	159020

RESISTORS

R1	120 K	1/2W	Fixed	Comp.	10%	AB	302124
R2	1 M	1/2W	Fixed	Comp.	10%	AB	302105
R3	100 K	1/2W	Fixed	Comp.	10%	AB	302104
R4	1.5 M	1/2W	Fixed	Comp.	10%	AB	302155
R5	10 ohm	1W	Fixed	Comp.	10%	AB	304100
R6	39 K	1/2W	Fixed	Comp.	10%	AB	302393
R7	680 K	1/2W	Fixed	Comp.	10%	AB	302684
R8	100 K	1/2W	Fixed	Comp.	10%	AB	302104
R9	1.5 M	1/2W	Fixed	Comp.	10%	AB	302155
R10	10 ohm	1/2W	Fixed	Comp.	10%	AB	302100
R11	10 ohm	1/2W	Fixed	Comp.	10%	AB	302100
R12	390 K	1/2W	Fixed	Comp.	10%	AB	302394
R13	47 K	1/2W	Fixed	Comp.	10%	AB	302473
R14	330 K	1/2W	Fixed	Comp.	10%	AB	302334
R15	1.5 M	1/2W	Fixed	Comp.	10%	AB	302155
R16	68 K	1W	Fixed	Comp.	10%	AB	304683
R17	200 K	1/2W	Fixed	Prec.	1%	CR	309051
R18	165 K	1/2W	Fixed	Prec.	1%	CR	309050

RESISTORS (cont.)

R19	100 K	1/2W	Fixed	Prec.	1%	CR	309045
R20	210 K	1/2W	Fixed	Prec.	1%	CR	309126
R21	150 K	1/2W	Fixed	Prec.	1%	CR	309049
R22	100 K	1/2W	Fixed	Prec.	1%	CR	309045
R23	15 K	5W	VAR.	WW	-210 v ADJUST	CTS	311013
R24							
R25							
R26							
R27	25 ohm	5W	Fixed	WW	5%	SPR	308026
R28	820 ohm	1/2W	Fixed	Comp.	10%	AB	302821

SWITCHES

SWI	Power Switch, SPST Toggle		BB	260134

TRANSFORMERS

T1	Power	117/220 v Primary	SR	120014

TRANSISTORS

Q1	2N176	-11 v Series Regulator	DE	156004
Q2	2N554	Darlington Transistor	DE	156009

VACUUM TUBES

V1	5651	Voltage Reference	TS	154052
V2	6AU6	-210 v DC Amplifier	WH	154022
V3A	1/2-6080	+95 v Series Regulator	TS	154056
V3B	1/2-6080	-210 v Series Regulator	TS	154056
V4	6AU6	+95 v DC Amplifier	WH	154022
V5	12B4	+250 v Series Regulator	TS	154045
V6	6AU6	+250 v DC Amplifier	WH	154022

CAPACITORS

C101	22 uuf	500 v	Tub.	10%	ER	281511
C102	22 uuf	500 v	Tub.	10%	ER	281511
C103	22 uuf	500 v	Tub.	10%	ER	281511
C104	12 uuf	500 v	Tub.	10%	ER	281505
C105A	7-45 uufd		Var.	10%	ER	281012
C105B	82 uufd	500 v	Tub.	10%	ER	281528
C105C	.001 ufd)					
C105D	.01 ufd)	matched timing capacitors			EX	295213
C105E	.1 ufd)					
C105F	1. ufd)					
C106	.001 ufd	500 v	Discap		RMC	283000
C107	.01 ufd	500 v	Discap		RMC	283005
C108	4.7 ufd	500 v	Tub.	10%	ER	281501
C109	.01 ufd	500 v	Discap		RMC	283005
C110	.001 ufd	500 v	Discap		RMC	283000
C111	22 uufd	500 v	Tub.	10%	ER	281511
C112	.001 ufd	500 v	Discap		RMC	283000
C113	22 uufd	500 v	Tub.	10%	ER	281511
C114	47 uufd	500 v	Tub.	10%	ER	281519
C115	47 uufd	500 v	Tub.	10%	ER	281519
C116	.01 ufd	500 v	Discap		RMC	283005
C117	22 uufd	500 v	Tub.	10%	ER	281511
C118	22 uufd	500 v	Tub.	10%	ER	281511
C119A	3-12 uufd		Var.	10%	ER	281007
C119B	7-45 uufd		Var.	10%	ER	281012
C119C	82 uufd		Tub.	10%	ER	281528
C119D	.001 ufd)					
C119E	.01 ufd)	matched timing capacitors			EX	295213
C119F	.1 ufd)					
C119G	1. ufd)					
C120	.01 ufd	500 v	Discap	10%	RMC	283005
C121	.01 ufd	500 v	Discap	10%	RMC	283005
C122	7-45 uufd		Var.	10%	ER	281012

DIODES

D101	CD1541	400 v	CD	152010
D102	IN662		CD	152017
D103	TI-55		TI	152009
D104	TI-55		TI	152009
D105	CD1541	400 v	CD	152010
D106	CD1541	400 v	CD	152010
D107	CD1541	400 v	CD	152010
D108 *	CD1541	400 v	CD	152025

*selected for low leakage

BULBS

B101	A060	60 v	NEON Aged & Polarized			SG	150010

RESISTORS

R101	120 K	1/2W	Fixed	Comp.	10%	AB	302124
R102	210 K	1/2W	Fixed	Prec.	1%	CR	309126
R103	47.5 K	1/2W	Fixed	MF	1%	IRC	310593
R104	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R105	22 K	1W	Fixed	MF	5%	CNG	310751
R106	332 K	1/2W	Fixed	MF	1%	IRC	310601
R107	100 K	1/2W	Fixed	MF	1%	IRC	310590
R108	8.25 K	1/2W	Fixed	MF	1%	IRC	310604
R109	680 ohm	1/2W	Fixed	Comp.	10%	AB	302681
R110	3.16K	1/2W		MF	1%	IRC	310656
R111 A&B	30 K/30 K	4W	Var.	WW	CYCLES/SEC	CL	311019
R112	1.2 M	1/2W	Fixed	Prec.	1%	CR	309149
R113	12 M	1/2W	Fixed	Prec.	1%	CR	309267
R114	60 M	1W	Fixed	Prec.	1%	CR	310731
R115	60 M	1W	Fixed	Prec.	1%	CR	310731
R116	182 K	1W	Fixed	MF	1%	IRC	310598
R117	47 K	1/2W	Fixed	Comp.	10%	AB	302473
R118	3.3 M	1/2W	Fixed	Comp.	10%	AB	302335
R119	100 K	1/2W	Fixed	MF	1%	IRC	310590
R120	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R121	15 K	5W	Var.	WW	RAMP DC LEVEL	CTS	311013
R122	10 K	5W	Fixed	WW	5%	WL	308054
R123	15 K	5W	Var.	WW	RAMP LENGTH	CTS	311013
R124	162K	1/2W	Fixed	MF	1%	IRC	310603
R125	150 K	1/2W	Fixed	MF	1%	IRC	310594
R126	47 K	2W	Fixed	Comp.	10%	AB	306473
R127	47 K	1/2W	Fixed	Comp.	10%	AB	302473
R128	1.5 M	1/2W	Fixed	Comp.	10%	AB	302155
R129	4.75 K	1/2W	Fixed	MF	1%	IRC	310599
R130	1 K	1/2W	Fixed	MF	1%	IRC	310605
R131	50 K	2W	Var.	(PART OF SW 105)	± DC LEVEL	CTS	311025
R132	22K	1W	Fixed	MF	5%	CNG	310751
R133	100 K	2W	Var.	Comp.	OUTPUT ATTEN.	AB	311026
R134	15 K	5W	Var.	WW	MIN. AMP. DC BALANCE	CTS	311013
R135	15 K	5W	Fixed	WW	5%	WL	308108
R136	4 K	5W	Fixed	WW	5%	WL	308102
R137	30 K	5W	Fixed	WW	5%	WL	308101
R138	22 M	1/2W	Fixed	Comp.	10%	AB	302226
R139	180 K	1/2W	Fixed	Comp.	10%	AB	302184
R140	56 K	1/2W	Fixed	Comp	10%	AB	302563
R141	15 K	1W	Fixed	Comp.	10%	AB	304153

RESISTORS (cont.)

R142	150 K	1/2W	Fixed	Prec.	1%	CR	309049
R143	150 K	1/2W	Fixed	Prec.	1%	CR	309049
R144	100 K	1/2W	Fixed	Prec.	1%	CR	309045
R145	100 K	1/2W	Fixed	Prec.	1%	CR	309045
R146	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R147	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R148	27 K	1W	Fixed	Comp.	10%	AB	304273
R149	1K	1/2W	Fixed	MF	1%	IRC	310605
R150	15 K	1W	Fixed	Comp.	10%	AB	304153
R151	500Ω	2W	Var.	WW	HOLD OFF LEVEL	CTS	311034
R152	150K	1/2W	Fixed	Prec.	1%	CR	309049
R153	56 K	1/2W	Fixed	Comp.	10%	AB	302563
R154	47 K	1/2W	Fixed	Comp.	10%	AB	302473
R155	68.1 K	5W	Fixed	WW	5%	SPR	310625
R156	475 K	1/2W	Fixed	MF	1%	IRC	310602
R157	130K	1/2W	Fixed	MF	1%	IRC	310611
R158	100 K	1/2W	Fixed	Comp.	10%	AB	302104
R159	220 K	1W	Fixed	MF	5%	CNG	310726
R160	15K	5W	Fixed	WW	5%	WL	308108
R161	15 K	5W	Var.	WW	TIMING	CTS	311013
R162	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R163	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R164	100 K	1/2W	Fixed	Comp.	10%	AB	302104
R165	50 K	1/4W	Var.	Comp.	SQ. WAVE AMPLITUDE	CTS	311077
R166	162 K	1/2 W	Fixed	MF	1%	IRC	310603
R167	15 K	5W	Var	WW	SQ. WAVE DC LEVEL	CTS	311013
R168	47 K	2W	Fixed	Comp.	10%	AB	306473
R169	6 M	1/2W	Fixed	Prec.	1%	CR	310720
R170	6 M	1/2W	Fixed	Prec.	1%	CR	310720
R171	60 M	1W	Fixed	Prec.	1%	CR	310731
R172	15 K	5W	Fixed	WW	5%	WL	308108
R173	15 K	5W	Var.	WW	SQ. WAVE SYMMETRY X10	CTS	311013
R174							
R175	3 K	1/2W	Fixed	MF	1%	IRC	310622
R176	332K	1/2W	Fixed	MF	1%	IRC	310644
R177	100 K	1/4W	Var	Comp.	SQ. WAVE SYMMETRY X1	CTS	311080
R178	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R179	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R180	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R181	100 K	1/2W	Fixed	MF	1%	IRC	310590
R182	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R183	100 ohm	1/2W	Fixed	Comp.	10%	AB	302101
R184	121 K	1/2W	Fixed	MF	1%	IRC	310591
R185	15 K	5W	Var.	WW	A SINE SHAPE	CTS	311013
R186	182 K	1/2W	Fixed	MF	1%	IRC	310598

RESISTORS (cont.)

R187	200 K	1/2W	Fixed	MF	1%	IRC	310615
R188	15 K	5W	Var.	WW	MILLER DC BALANCE	CTS	311013
R189	22.1 K	1/2W	Fixed	MF	1%	IRC	310626
R190	82 K	1/2W	Fixed	Prec.	1%	CR	309117
R191	50 K	1/4W	Var.	Comp.	TRI DC LEVEL	CTS	311077
R192	165 K	1/2W	Fixed	Prec.	1%	CR	309050
R193	15 K	5W	Var.	WW	B SINE SHAPE	CTS	311013
R194	1 K	1/2W	Fixed	MF	1%	IRC	310605
R195	1 M	1/2W	Fixed	MF	1%	IRC	310609
R196	82.5 K	1/2W	Fixed	MF	1%	IRC	310616
R197	162 K	1/2W	Fixed	MF	1%	IRC	310603
R198	1.5 M	1/2W	Fixed	MF	1%	IRC	310612
R199	1 K	1/2W	Fixed	MF	1%	IRC	310605
R200	523 K	1/2W	Fixed	MF	1%	IRC	310618
R201	10 K	1/2W	Fixed	MF	1%	IRC	310600
R202	15 K	5W	Var.	WW	C SINE SHAPE	CTS	311013
R203	600 K	1/2W	Fixed	Prec.	1%	CR	309142
R204	150 K	1/2W	Fixed	Prec.	1%	CR	309049
R205	1.5 M	1/4W	Var.	Comp.	TRI. AMP.	CTS	311079
R206	47 K	2W	Fixed	Comp.	10%	AB	306473
R207	121 K	1/2W	Fixed	MF	1%	IRC	310591
R208	50 K	2W	Var.	Comp.	SINE DC LEVEL	CL	311023
R209	1.5 M	1/2W	Fixed	MF	1%	IRC	310612
R210	47 K	2W	Fixed	MF	5%	CNG	310716

SWITCHES

SW101	DPST Push Button.	Manual	GR	260247
SW102	3 wafer, 2 pos., Rotary	Trigger	OAK	260002
SW103	6 wafer, 7 pos., Rotary	Multiplier	OAK	260000
SW104	1 wafer, 4 pos., Rotary	Output	OAK	260001
SW105	SPDT ± DC Level (ganged with R 131)		CTS	311025

VACUUM TUBES

V101A	1/2-6U8A	Sq. Multi CF	AMX	154033
V101B	1/2-6U8A	Sq. Output CF	AMX	154033
V102A	1/2-6BL8	Miller Integrator	AMX	154057
V102B	1/2-6BL8	Miller Integrator CF	AMX	154057
V103A	1/2-6U8A	Triangle Out CF	AMX	154033
V103B	1/2-6U8A	Sine Out CF	AMX	154033
V104	12AU6	Sine Sharper Amplifier	WH	154044
V105	6BL8	Sq. Wave Generator	AMX	154057

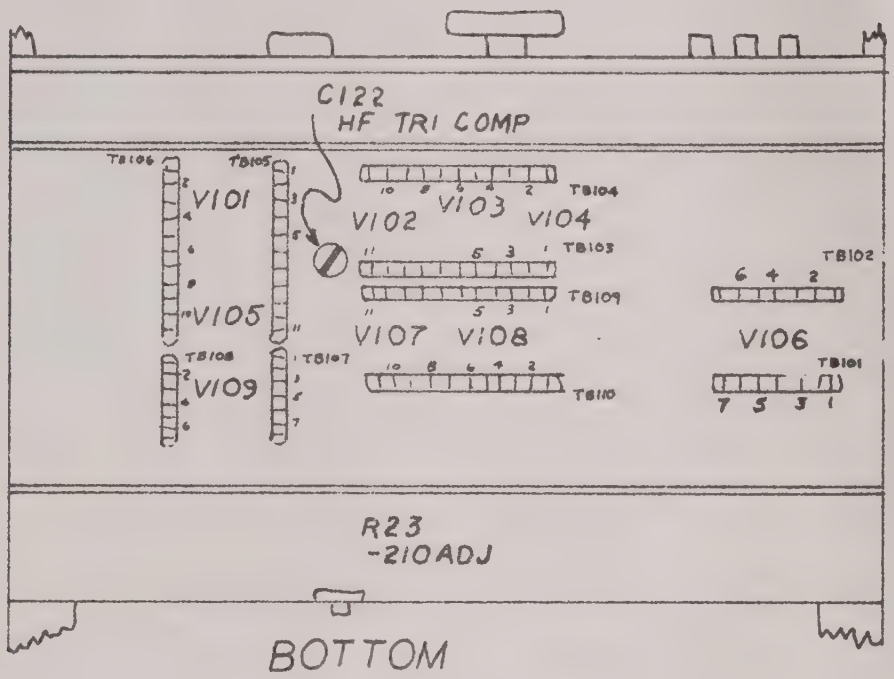
VACUUM TUBES (cont.)

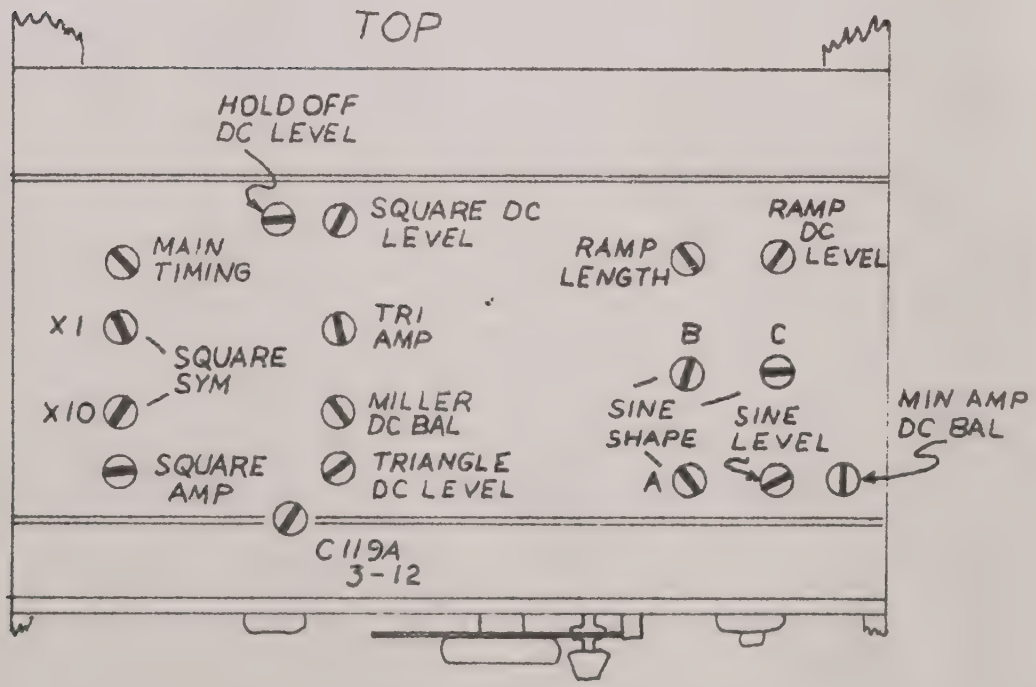
V106A	1/2-12BH7	Ramp Out CF	WH	154046
V106B	1/2-12BH7	Main Out CF	WH	154046
V107A	1/2-6BL8	Ramp Integrator	AMX	154057
V107B	1/2-6BL8	Ramp Integrator CF	AMX	154057
V108	6DJ8	Ramp Gate	AMX	154187
V109	6DJ8	Hold Off Multi	AMX	154187
V110	6BL8		AMX	154057

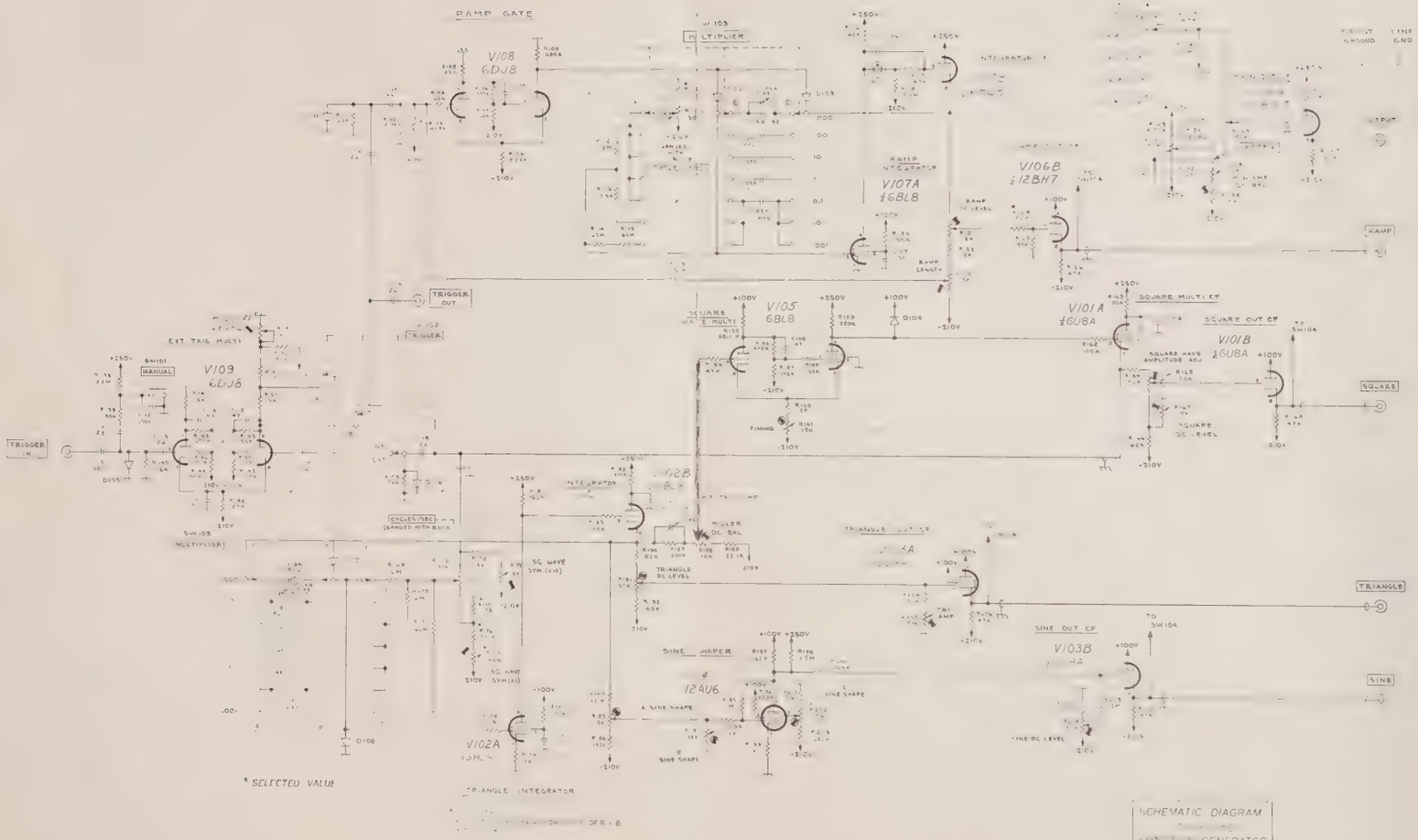
SECTION V

CIRCUIT DIAGRAM

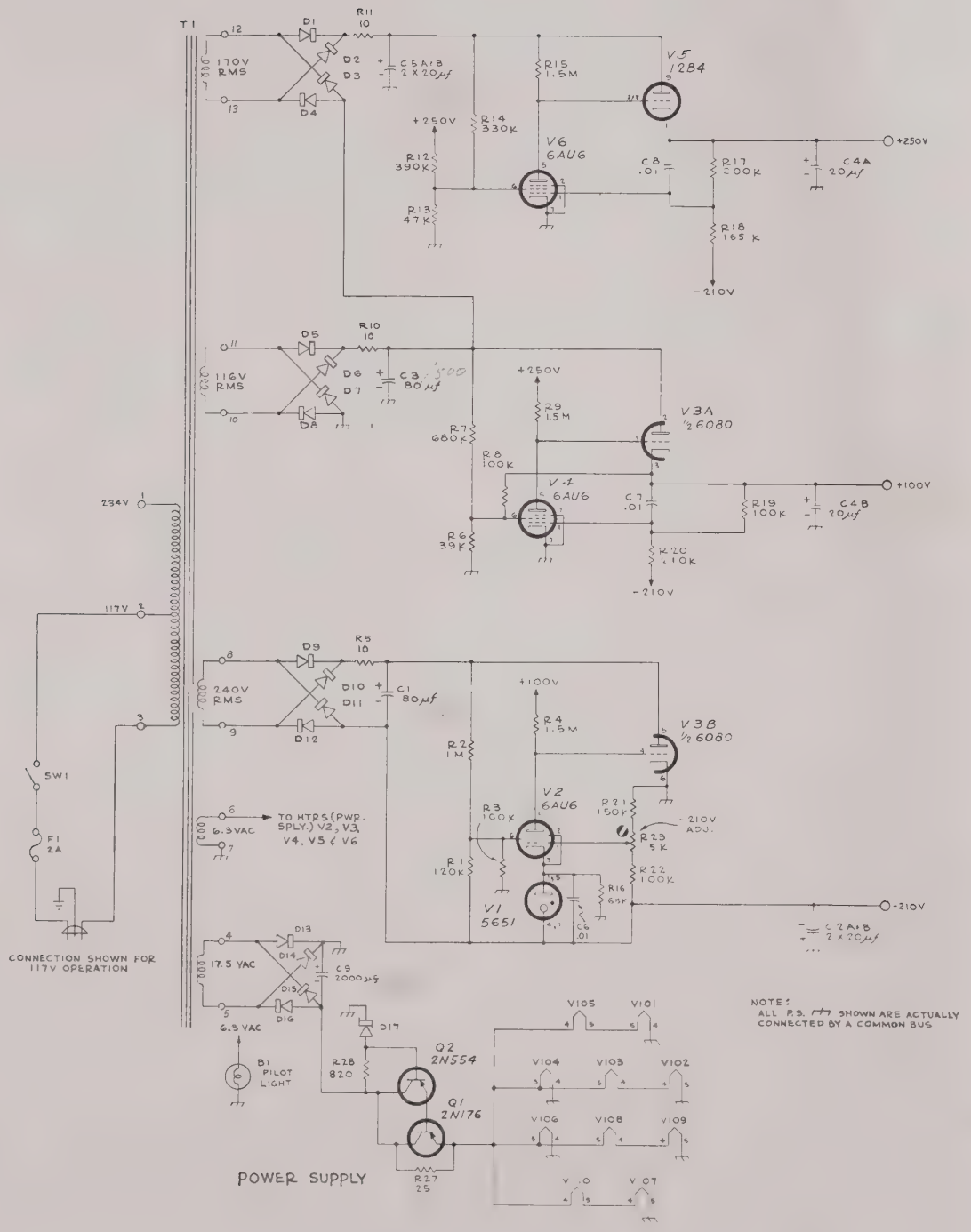
2.2 CHASSIS LAYOUT





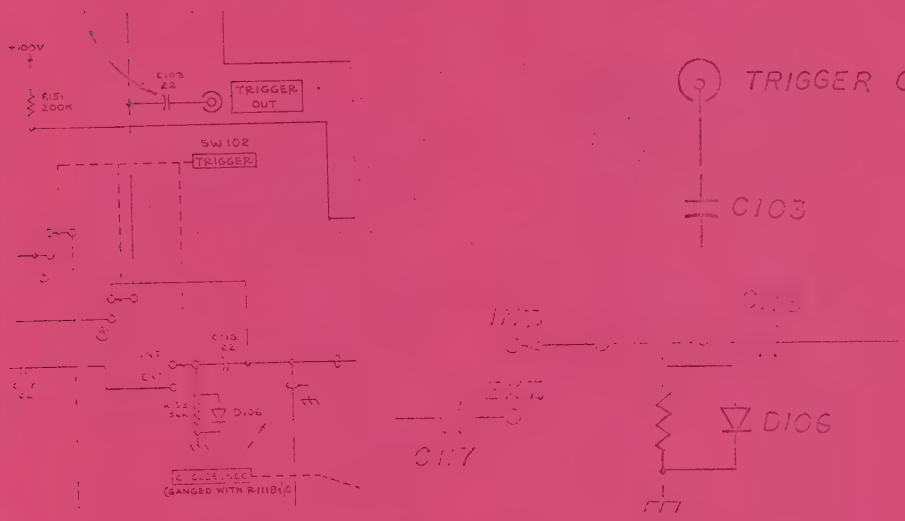


SCHEMATIC DIAGRAM


T1
D1
R11
10
170V RMS
D2
D3
D4
C5A+B 2 x 20µf
R15 1.5M
V5 1284
+250V
R14 330K
R12 390K
V6 6AU6
R13 47K
C8 .01
R17 100K
C4A 20µf
+250V
R18 165K
-210V
D5
R10
10
116V RMS
D6
D7
D8
C3 80µf
+250V
R9 1.5M
V3A ½ 6080
R7 680K
R8 100K
V4 6AU6
C7 .01
R19 100K
C4B 20µf
+100V
R6 39K
R20 110K
-210V
234V
117V
D9
R5
10
240V RMS
D10
D11
D12
C1 80µf
+100V
R4 1.5M
V3B ½ 6080
R2 1M
V2 6AU6
R3 100K
R21 150K
-210V ADJ.
R23 5K
R1 120K
R22 100K
V1 5651
R16 68K
C6 .01
-210V
C2A+B 2 x 20µf
SW1
F1 2A
6.3VAC
TO HTRS (PWR. SPLY.) V2, V3, V4, V5 & V6
CONNECTION SHOWN FOR 117V OPERATION
D13
D14
D15
D16
17.5 VAC
C9 2000µf
6.3 VAC
D17
B1 PILOT LIGHT
R28 820
Q2 2N554
Q1 2N176
R27 25
POWER SUPPLY
V105
V101
V104
V103
V102
V106
V108
V109
V110
V107
NOTE: ALL P.S. SHOWN ARE ACTUALLY CONNECTED BY A COMMON BUS

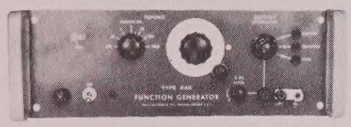
CIRCUIT MODIFICATIONS

C103 IN TRIGGER OUT CIRCUIT IS NOW CONNECTED AS SHOWN IN SKETCH AT RIGHT. THIS CHANGE IMPROVES THE CHARACTERISTICS OF THE NEGATIVE GOING TRIGGER SPIKE.



FUNCTION GENERATORS

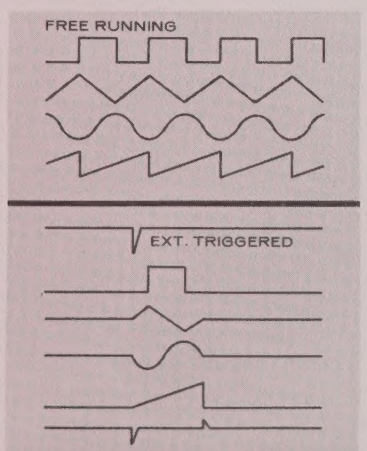
TYPE 240



The Type 240 is a basic Function Generator producing simultaneous free-running square, triangle and sine waveforms from 0.001 cps to 10 kcs. A separate (MAIN) output is switched to provide any one of the three waveforms, with adjustable amplitude (up to 25 v p-p) and reference level (—15 to +15 v). The MAIN output can be referenced to chassis or circuit ground. PRICE: $475.

TYPE 250

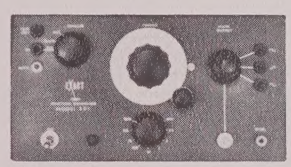
The Type 250 is a four-waveform Function Generator (square, triangle, sine and ramp) which can be triggered or operated free-running from 0.001 cps to 10 kcs. Each input trigger pulse produces one complete cycle at all outputs. A pushbutton permits manual triggering of all outputs for one-shot applications. Each waveform is available at an auxiliary output (30 v p-p). A separate (MAIN) output is switched to provide any of the four waveforms with adjustable amplitude (0-25 v p-p) and reference level. A trigger output pulse train is also provided to synchronize external equipment. PRICE: $595.



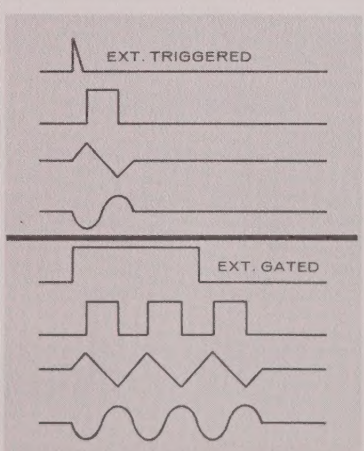
TYPE 251

The Type 251 is identical to the 250 with the addition of a simultaneous cosine waveform available as an auxiliary output and a selectable waveform at the MAIN output The cosine waveform lags the sine waveform by 90°. PRICE: $685.

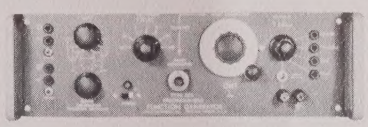
TYPE 301



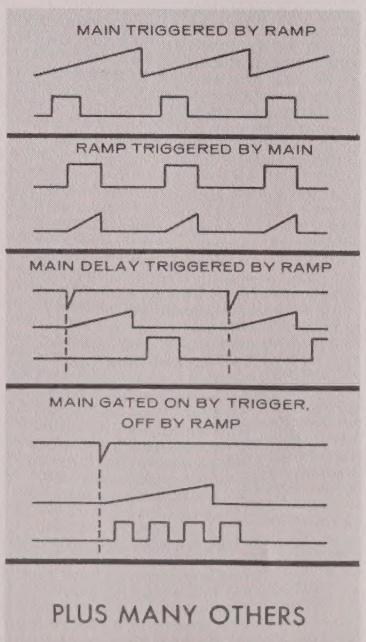
The Type 301 is an all solid-state Function Generator which produces simultaneous square, triangle and sine waveforms at 0.001 cps to ONE MEGACYCLE. Each waveform is provided at an auxiliary output at 12 volts p-p fixed amplitude (into 500 ohms). A separate (MAIN) output is switched to provide any of the three waveforms with adjustable amplitude (0-10 v p-p, source impedance is 5 ohms). All outputs are simultaneous and synchronized and can be free-running, externally triggered, or gated. The square-wave output exhibits a 10 nanosecond risetime/falltime which occurs at the sine and triangle peaks. A trigger output signal is provided for synchronizing other equipment. PRICE: $550.



TYPE 255



The 255 Function Generator consists of two discrete units: a main generator producing square, triangle, and sine waveforms; and a ramp generator. The two generators are completely independent, having separate timing and multiplier (frequency) controls (0.001 cps to 10 kc). Front panel program switches permit cross-connecting input/output signals between generators, providing many gated, pulsed, and delayed operating modes. Each generator can be externally triggered. Either generator can trigger the other, and the ramp generator can be used to gate the main generator. A dc holdoff control varies the starting point of triggered or gated square, sine and triangle waveforms over nearly 180°. The main generator provides a trigger output signal, and the ramp generator provides a gate output signal. All outputs are simultaneous and the main output is switched to provide any of the four waveforms with adjustable amplitude (0-25 v p-p). PRICE: $785.

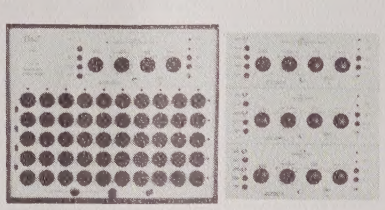

MAIN TRIGGERED BY RAMP
RAMP TRIGGERED BY MAIN
MAIN DELAY TRIGGERED BY RAMP
MAIN GATED ON BY TRIGGER, OFF BY RAMP
PLUS MANY OTHERS

EXACT ELECTRONICS INC.
455 S.E. 2nd Avenue, Hillsboro, Oregon 97123

printed in U.S.A.

WAVEFORM SYNTHESIZERS

TYPE 200 B, D & F ANALOG WAVEFORM SYNTHESIZERS



Typical analog outputs consist of selected slopes, both positive and negative going. The slopes may be continuous or non-continuous, and are individually adjustable for width or amplitude. Intentionally distorted waveforms or complex shaker table programs can easily be produced with an analog waveform synthesizer.

WARRANTY

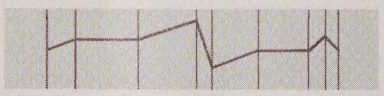
All EXACT instruments are fully warranted against defective materials and workmanship for one year. Responsible maintenance centers are located in major cities.

REPRESENTATIVES

EXACT maintains representatives in more than 26 U.S. cities and more than 17 foreign countries.

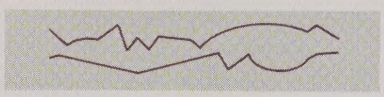
TYPE B PLUG-IN

When a Type B Plug-in is used with the Waveform Synthesizer, each of the 50 dual controls adjusts the slope and width of one increment. Changing the slope or width of any increment changes the dynamic position of the subsequent increment, providing a waveform of continuous slopes. In addition, an expansion control allows greater variation in the relative widths of individual increments.



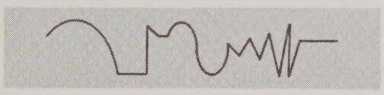
TYPE D PLUG-IN

When a Type D Plug-in is used with the Waveform Synthesizer, two simultaneous outputs are generated. Each dual-control separately adjusts the slopes of both waveforms during each respective increment. The two waveforms consist of continuous slopes, i.e., the end of one increment is the starting point of the next increment.

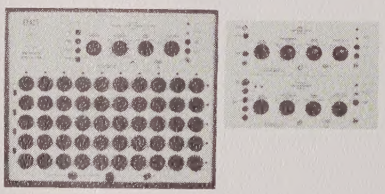


TYPE F PLUG-IN

When a Type F Plug-in is used with the Waveform Synthesizer, each dual-control adjusts the slope and amplitude during each respective increment. Two outputs are provided, one with continuous slopes (see D Plug-in) and one with non-continuous slopes.



TYPE 200 C & E DIGITAL WAVEFORM SYNTHESIZERS



WAVEFORM SYNTHESIZERS

Type 200 Waveform Synthesizers generate complex waveforms as fifty sequential increments with two parameters adjustable for each increment. Output programs can be either free-running or triggered (1-program/trigger, 1-row/trigger, 1-increment/trigger). Program duration is adjustable from 33 us to over one minute. Output waveforms may be of either digital (Types C and E Plug-ins) or analog (Types B, D and F Plug-ins) character.

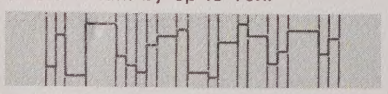
Typical digital outputs consist of up to 100 pulses of varying widths and amplitudes. Digital waveform synthesizers are commonly used to simulate telemetric and video signals.

GENERAL SPECIFICATIONS

Risetime/Falltime .....0.25 usecs max.
Amplitude Stability 2%
Time Jitter .....1 part in 500
Repeatability .....2% (short term)
5% (long term)
Power ..... 105-125/210-250 vac
50-60 cps, 375 watts
Size .....17½w x 15½h x 14½d
Weight .....Type 200: 51 lbs.
Plug-in Units: 6 lbs.

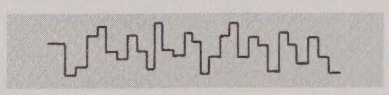
TYPE C PLUG-IN

When a Type C Plug-in is used with the Waveform Synthesizer, each dual-control adjusts the amplitude and width during each respective increment. The duration of the program is the sum of the widths of the component increments, each increment being variable from 2us to 300 ms in width. In addition, an individual increment expansion control increases width by up to 10x.



TYPE E PLUG-IN

When a Type E Plug-in is used with the Waveform Synthesizer, 100-increment programs can be produced. Each dual-control adjusts the amplitude during two increments (1 and 51, 6 and 56, 24 and 74, etc.), and increment width is variable from 2 us to 1 second.



DOMESTIC PRICES*
(approximately 5% higher overseas)

Type 200	$1,925
Type B Plug-In Unit	500
Type C Plug-In Unit	350
Type D Plug-In Unit	400
Type E Plug-In Unit	350
Type F Plug-In Unit	350

*FOB Factory: Complete with 2 copies of instruction manual

Telephone(503) 648-6661
TWX:503-821-6927

Represented By